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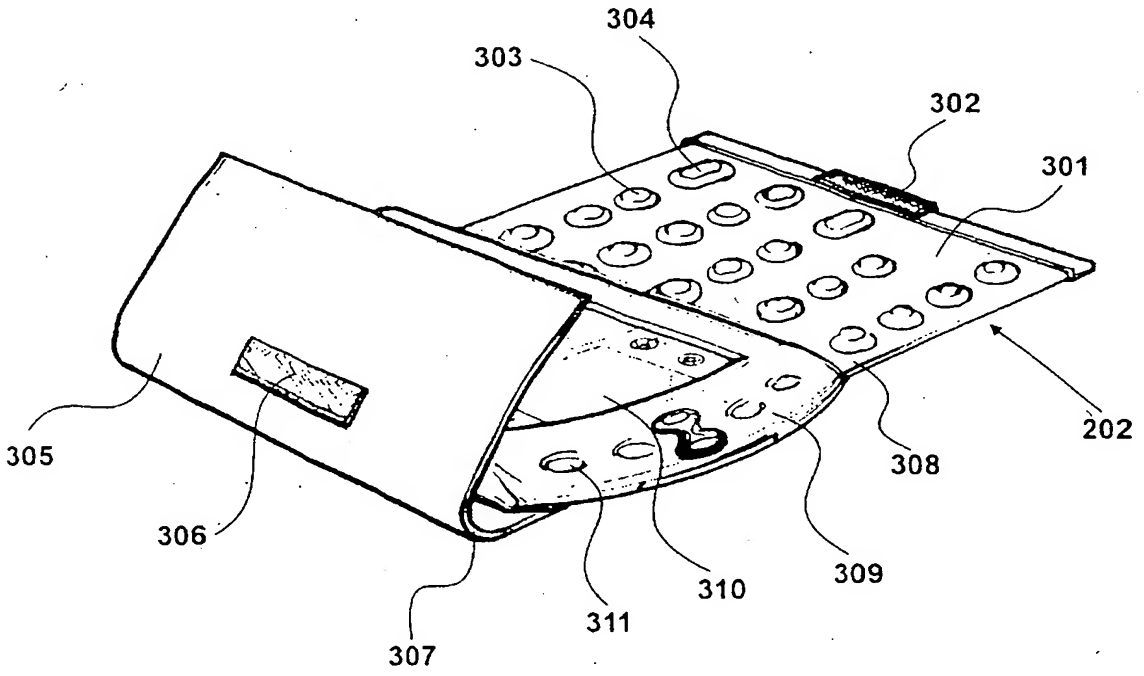

(57) Abstract: The present invention relates to a manually operable input apparatus (202) for a portable electronic processing device (102), such as a mobile phone or hand-held processor. The apparatus defines a plurality of regions (303, 304) each representing a respective data item and comprises a plurality of sheets configured to produce a response to a mechanical interaction. Furthermore, the sheets are configured to be wrapped around the device to provide a protective cover.

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Manual Input Apparatus And Processor

The present invention relates to a manually operable input apparatus in combination with a hand-held processor, and more particularly where the manually operable input apparatus is wrapped around the hand-held processor to form a protective cover.

Manually operable input apparatus for portable electronic processing devices are known. For example, it is possible to connect a portable keyboard to hand-held computing devices such as those sold under the trademark "PALM".

Known keyboards of this type are essentially rigid in construction and made portable by the provision of hinges. However, arrangements of this type add significantly more additional bulk to the overall device and, therefore, would tend not to be carried around with the device at all times.

Palm devices and other similar portable electronic processing devices often include some sort of keyboard, such as an on screen keyboard, but these tend to be relatively small, as in the palm devices, or of a restricted nature. Thus, for example, it is possible to enter alpha-numeric data using a telephone type keyboard on mobile cellular telephones for example using only the numeric keypad. Generally, this is relatively time consuming in that several presses of a key are often required in order to emulate a provision of a full size keyboard. Sophisticated algorithms are known to facilitate the operation of devices of this type but generally they are far from ideal and make the entry of text messages relatively cumbersome compared to the facilities available when provided with a larger size keyboard.

According to the present invention there is provided a manually operable input apparatus for a portable electronic processing device, defining a plurality of regions each representing a respective data item, said manually operable input apparatus comprising a plurality of sheets configured to produce a response to a mechanical interaction,

wherein said sheets are configured to be wrapped around said device to provide a protective cover.

In an embodiment of the invention, the manually operable input apparatus of the present invention is an alpha numeric keyboard. In a preferred embodiment, the keyboard comprises one or more sheets of fabric. In a further preferred embodiment, the keyboard is a membrane keyboard.

The portable electronic processing device is preferably a hand-held device such as a mobile phone or a hand-held processor such as those sold under the trademark 'PALM'. By hand-held we mean that an operator of the device may conveniently hold the device in their hand during normal operation of the device. This should be distinguished from a normal desk top computer whereby the computer, during normal use, remains stationary on the desk top. In addition, it should be distinguished from a portable device such as a lap top computer whereby the device is portable from one location to another, but remains stationary on a surface during operation. Such desk-top and portable devices may not conveniently be hand-held during normal use.

The invention will now be described by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a person transporting a device according to the present invention;

Figure 2 shows a first embodiment of the present invention in a wrapped configuration;

Figure 3 shows the apparatus of *Figure 2* in a part-unfolded configuration;

Figure 4 shows the apparatus shown in *Figure 2* in the intermediate configuration;

Figure 5 is a further rear view of the device shown in *Figure 4* detailing the self-erecting stand assembly;

Figure 6 is a further rear view of the self-erecting stand assembly shown in *Figure 5* in a transitional position;

Figure 7 is a further rear view of the device shown in *Figure 5* detailing the self-erecting stand assembly in the operational configuration;

Figure 8 is a front perspective view of the device shown in *Figures 2* to *7* in the operational configuration;

Figure 9 is an exploded perspective view of the fabric keyboard **202** shown in *Figure 8*;

Figure 10 details the electrically conductive fabric layers **901** and **902** shown in *Figure 9*;

Figure 11 shows a detailed view of the interface circuit **503** of *Figure 5*;

Figures 12A, *12B*, *12C* and *12D* detail schematically the pressure and positional measurements that can be made by the interface circuit identified in *Figure 11*;

Figure 13 is a flow chart illustrating a mode of operation performed by the PIC16C711 processor shown in *Figure 11*;

Figure 14 is a flow chart detailing the initialisation procedure performed by the PIC16C711 processor at step **1301** shown in *Figure 13*;

Figure 15 is a further flow chart detailing the configurations of the PIC16C711 processor for the collection of Z value data as indicated in step **1302** of *Figure 13*;

Figure 16 is a flow chart detailing the configuration of the PIC16C711 processor for the collection of X, Y co-ordinate positional data and Z axis data as indicated in step **1304** of *Figure 13*.

Figures 17A and *17B* show a cross-sectional view taken through a key registration device of the fabric keyboard **202** during a key press;

Figure 18 shows a second embodiment of the present invention in the wrapped configuration;

Figure 19 shows the embodiment shown in *Figure 18* with the elastic strap **1803** released;

Figure 20 shows the second embodiment of the invention in the intermediate configuration;

Figure 21 shows the second embodiment of the invention in a transitional configuration;

Figure 22 shows the second embodiment in the operational configuration;

Figure 23 shows a third embodiment of the present invention in the operational configuration;

Figure 24 shows a further embodiment of the device shown in *Figure 23* having a keyboard provided with an alternative securing means;

Figure 25 shows the device of *Figure 24* in the intermediate configuration;

Figure 26 shows the device shown in *Figures 24* and *25* in the wrapped configuration;

Figure 27 is a rear view of a hand-held processor detailing the serial interface connection pins;

Figure 28 shows the keyboard **2401** shown in *Figure 24* connected to a mobile phone;

Figure 29 shows a further embodiment of the present invention in the operational configuration;

Figure 30 shows the embodiment shown in *Figure 28* in the wrapped configuration;

Figure 31 details the wiring formed between the hand-held processor and the fabric keyboard of the embodiment shown in *Figures 29* and *30*;

Figure 32 is an exploded view of an alternative membrane keyboard embodiment of the manually operable input apparatus;

Figure 33 is a detailed view of the electrically conductive membrane layers **3202** and **3203** shown in *Figure 32*;

Figure 34 details the modified interface circuitry for the operation of the membrane keyboard shown in *Figures 31* and *32*;

Figure 1

Figure 1 shows an operator **101** removing a device **102** according to the present invention from a pocket **103** in trousers **104**. The device **102** is of suitable size and shape so as to enable convenient transportation of the device either in a pocket of a pair of trousers as shown in *Figure 1* or,

alternatively, in another environment such as a briefcase or a bag. The device **102** comprises an electronic processor device in the form of a hand-held processor (not shown) encapsulated within a protective covering which forms the external surface of the device **102**. In this embodiment, the protective covering is formed by a manually operable input apparatus wrapped around the hand-held processor and configured to be used in combination with the hand-held processor to input data. The protective cover formed by the manually operable input apparatus is a flexible and durable fabric configured to protect the structural integrity of the encapsulated hand-held processor.

Figure 2

A perspective view of a first embodiment of the device **102** of the present invention in the wrapped configuration is shown in *Figure 2*. The hand-held electronic processor **201** is completely encapsulated by the manually operable input apparatus which, in the present embodiment, is in the form of a fabric keyboard **202**. The hand-held processor **201** is a Palm^{RTM} Vx Processor manufactured by 3Com.

In the wrapped configuration shown in *Figure 2*, the fabric keyboard **202** forms a protective covering configured to prevent the scratching of the surface of the hand-held processor **202** and, in addition, to provide cushioning to prevent impacts adversely affecting the structural integrity of the processor. The fabric keyboard is secured in the wrapped configuration by a hook and loop fastener such as Velcro (not shown) which will be described further in reference to *Figure 3*.

Figure 3

The device **102** illustrated in *Figure 2* is shown in a part-unfolded configuration in *Figure 3*. The fabric keyboard **202** is shown in *Figure 3* having a first accessible lateral portion **301** in a completely unfolded position. The internal surface of the first lateral portion **301** of fabric keyboard **202** has a hook strip **302** on its internal surface which forms part of the securing Velcro fastener. Also located on the internal surface of the fabric keyboard **202** are key registration device protrusions such as **303** and **304**. The key registration device protrusions have a corresponding graphical icon printed thereon to identify the function and/or the alpha numerical input to which the key registration device corresponds.

A second lateral portion **305** is shown in *Figure 3* in a partially bent over position. On the external surface of the second lateral portion **305** is a loop strip **306** which is configured to be releasably engaged with the hook strip **302** on the internal surface of the first lateral portion **301** to secure the first and second lateral portions together in the wrapped configuration as shown in *Figure 2*.

In addition to the first and second lateral portions of the fabric keyboard **202**, there is a central portion (not visible in *Figure 3*) on to which the hand-held processor **309** is located. The first and second lateral portions **301** and **305**, and the central portion are defined by two bend portions indicated at **307** and **308**. During the bending operations performed on the fabric keyboard **202** to form the wrapped configuration shown in *Figure 2*, the bend portion **307** bends around a side edge of the hand-held processor **309** along a first axis and the bend portion **308** bends

along the opposing side edge of the hand-held processor **309** along a second axis. The relationship between the first and second axis is dictated by the precise shape of the hand-held processor **309** about which the fabric keyboard **202** is to be wrapped. In the embodiment shown in *Figure 3*, the hand-held processor **309** has two parallel side edges and, correspondingly, the first and second axis about which portions **307** and **308** bend respectively are disposed in a parallel relationship to one another.

Figure 4

Figure 4 shows the device **102** being used in an intermediate configuration. The device **102** is supported by an operator's hand **402** and the first lateral portion **301** and the second lateral portion **305** of the keyboard **202** are shown substantially in the non-bent position with the hand-held processor **309** located centrally on a central portion of the keyboard between the two lateral portions of the keyboard **202**. Key registration devices such as, for example **303** and **304**, are visible on the internal surfaces of the first and second lateral portions **301** and **302**.

In the intermediate configuration shown in *Figure 4*, the hand-held processor **309** is arranged such that the screen **310** and buttons such as **311** are revealed to the operator **101**. The operator **101** can select specific data items by interacting with the screen **310** using the stylus **401** or by pressing the button, such as **311**. Accordingly, the operator **101** can interact with the hand-held processor **309** using the second free hand **403** which is shown in *Figure 4* selecting an icon on the screen of the hand-held processor using the stylus **401**. Hence, in the intermediate configuration, the hand-held processor **309** may be operated without using the keyboard

202. Therefore, if the operator only wishes to use the hand-held processor device **309** alone, it is only necessary to reconfigure the device **102** from the wrapped configuration to the intermediate configuration as shown in *Figure 4*. Furthermore, when the operator **101** has completed the necessary operations on the hand-held processor device **309**, the device may be conveniently reconfigured to the wrapped configuration for transportation by bending the second lateral portion **305** over the exposed face of the hand-held processor device **309** and subsequently bending the first lateral portion **301** over the remainder of the exposed face of the hand-held processor **309** and securing the first lateral portion to the second lateral portion.

If the operator **101** should wish to use the keyboard **202** in conjunction with the hand-held processor **309** then it is necessary to reconfigure the apparatus from the intermediate position to the operational position. The process by which this is achieved will be described in reference to *Figures 5, 6* and *7*.

Figure 5

Figure 5 shows a rear view of a self-erecting stand assembly **501** located on the surface of the keyboard **202** in the intermediate position. The self-erecting stand assembly **501** is not visible in *Figure 4* as it lies directly adjacent to the surface of the keyboard **202** and is concealed behind the hand-held processor **309**. Consequently, and for the purpose of illustration only, the hand-held processor has been omitted from *Figure 5* to enable the self-erecting stand assembly **501** to be clearly visible. In the intermediate configuration, the self-erecting stand assembly **501** lies directly adjacent to

the keyboard surface in contact with the key registration devices of the central portion (not shown).

The self-erecting stand assembly **501** comprises a hand-held processor engaging portion **502** which is configured to engage the hand-held processor **309** into position on the assembly **501**. An interface circuit **503** is located adjacent to the hand-held processor engaging portion **502** and is configured to engage with the corresponding input connections of the hand-held processor **309** such that a connection between the interface circuit and the hand-held processor **309** is formed when the hand-held processor is located on the self-erecting stand assembly **501**. The interface circuit **503** is connected to the keyboard **202** by a flexible fabric cable having electrical connection elements contained therein, and which runs along the length of the support stand assembly **501** and forms a connection with the keyboard at the base **508** of the assembly **501**.

The main body of the self-erecting support stand assembly comprises three plastic support portions. The first plastic support portion **505** is integrally formed with the hand-held processor engaging portion **502**. Spaced apart from the first plastic support portion **505** is a second plastic support portion **506** which is spaced apart from a further third plastic support portion **507**. The third plastic support portion **507** is connected to the keyboard at base **508**. A support leg **504** is hingeably attached to the first portion **505** and extends through slots **509** and **510** of the third plastic support portion **507**. In the intermediate configuration as shown in *Figure 5* the plastic support portions and the support leg **504** are arranged in a flat configuration over the surface of the keyboard **202** to provide the minimum amount of bulk to the device **102** in the intermediate and wrapped

configurations.

Figure 6

A further view of a transitional configuration in which the self-erecting stand assembly **501** is sliding from the intermediate configuration to the operational configuration is shown in *Figure 6*. The back surface of the hand-held processor **309** is shown supported on the self-erecting stand assembly **501** by the first plastic support portion **505** and the hand-held processor engaging portion **502**. As previously mentioned, the interface circuit **503** is electrically connected to the hand-held processor **309** when the processor is located onto the self-erecting stand assembly **501**. The self-erecting stand assembly **501** is flexing on either side of the second plastic support portion **506** and between the third plastic support portion **507** and the keyboard **202**. The flexing at these positions is facilitated by bending of the flexible fabric cable which runs from the base **508** to the interface circuit **503** and connects the first, second and third plastic support portions together. In an alternative embodiment, the connection between the base **508** and the keyboard and the first, second and third plastic support portions are hinged so as to facilitate the appropriate bending between the sections.

In the transitional configuration, the port leg **504** is extended outwards through slots in the third plastic support portion **507**.

Figure 7

Figure 7 shows the self-erecting stand assembly **501** in the operational configuration. The continued slide of the self-erecting stand

assembly from the transitional configuration shown in *Figure 6* results in the first plastic support portion **505** travelling further towards the third plastic support portion **507** whilst the support leg **504** extends further outwards to engage with the surface onto which the device **102** is placed.

In the operational configuration, the hand-held processor device **309** is supported in an elevated position spaced apart from the keyboard **202**. Accordingly, the central portion of keyboard **202** is revealed so as to enable access to the entire keyboard surface. Although the fabric keyboard **202** is of effectively continuous form, the central portion **701** can be considered as being effectively divided from the first lateral portion **301** and the second lateral portion **305** by the bending of the fabric keyboard along the first axis indicated by reference to the dotted line **702** and the second axis indicated by dotted line **703** which corresponds to bend portions **307** and **308** respectively.

When an operator has finished using the device in the operational configuration, the device may be reconfigured back to the wrapped configuration by returning the self-erecting stand assembly to the flat position of the intermediate configuration. This procedure, in effect, folds the flexible connection cable over at base **508** about a third axis so that the hand-held processor is located adjacent to the central portion **701** of the keyboard. The second lateral portion is then bent around the edge of the hand-held processor about a first axis **702** and the first lateral portion is bent around the opposing surface about the second axis **703**. The first axis and the second axis are substantially perpendicular to the third axis. The first and second lateral portions are then secured in the wrapped configuration.

Figure 8

A front perspective view of the device **102** in the operational configuration is shown in *Figure 8*. The hand-held processor device **309** is centrally located with respect to the keyboard **202** and supported in an elevated position relative to the plane of the keyboard by the support leg **504**. In the operational configuration, all the keys on the surface of the keyboard are accessible so as to enable an operator full access to the keyboard. The application of a mechanical pressure by the operators' finger to a key registration device, such as, for example **303** or **304**, results in the transmission of an alpha numeric or function data entry to the hand-held processor **309** which is displayed on the screen **310**.

In some modes of operation, the hand-held processor displays a keyboard on its LCD display screen **310** and individual keys may be selected by manual operation of a stylus **410** upon the screen **310**, for example, as in the intermediate position shown in *Figure 4*. The purpose of keyboard **202** is to effectively replace the function of this displayed keyboard thereby allowing an operator to make use of the keyboard by direct application of their fingers, in a manner substantially similar to the operation of a standard manual keyboard. In this way, the entry of alpha numeric data can take place more rapidly and in a way which is generally more familiar to operators' and users.

A further important feature of the keyboard **202** is also shown in *Figure 8*. The key registration devices such as **303** and **304** are relatively small truncated cone projections arranged in a spaced apart configuration on the surface of the keyboard **202**. This configuration is preferable as it is

necessary that the key registration devices are sufficiently small and sufficiently spaced so as to prevent undue compression of keys occurring on bending the fabric keyboard. In this regard, it will be evident that large bulky key registration devices upon bending will be compressed together and may require a greater force to be applied to form the bends and a strong securing means to retain the keyboard in the wrapped configuration. Accordingly, the keyboard as a whole should be configured to minimise the compression of the keys during bending to enable a bend to be readily formed.

A final important feature of the embodiment described in reference to *Figures 2* to *8* is that the hand-held processor device remains connected to the keyboard during all the bending operations (ie it can remain permanently connected during normal use) and obviates any requirement to connect and disconnect the processor during the reconfiguration processes.

Figure 9

An exploded perspective view of the keyboard of *Figure 8*, illustrating its constituent layers, is shown in *Figure 9*. The fabric keyboard **202** comprises ten individual constituent layers, including a first electrically conductive layer **901** and a second electrically conductive layer **902**. Both of the electrically conductive fabric layers **901** and **902** have electrically conductive carbon coated fibres woven or knitted together such that each conductive layer is capable of conducting an electrical current in any direction along the plane of that individual layer.

The first electrically conductive layer **901** has conductive tracks **911** and **912** forming an electrical contact along the left and the right edges of the fabric keyboard respectively. The conducting tracks may be fabricated from fabric coated with conductive metals, such as silver or nickel. Material of this type is readily available and is used extensively for shielding equipment from electromagnetic interference. The tracks are secured to the conductive layers **901** and **902** using a conductive adhesive.

The tracks **911** and **912** are highly conductive compared with the fabric of sheets **901** and **902**. Accordingly, a voltage gradient may be applied across the first electrically conductive layer **901** between the right and left edges of the detector (ie in an X-axis direction). The second electrically conductive layer **902** has conductive tracks **913** and **914** providing electrical contact along the top and bottom edges of the fabric layer respectively. Accordingly, a voltage may be applied across the second electrically conductive fabric layer **902** in a direction perpendicular to the voltage which is applied across the first electrically conductive layer **901** (ie the voltage across layer **902** is in the Y-axis direction).

The uppermost layer of the fabric keyboard is a continuous fabric layer **903** which has printed on its upper surface graphical representations corresponding to the alpha numeric keys of the keyboard. The graphical representations are preferably screen printed onto the fabric layer and, during the preferred construction process, the printing of the alpha-numerical graphical representations is performed once the fabric keyboard has been assembled. Furthermore, the fabric layer **903** is preferably made from a stretchable and heat formable fabric so as to enable the fabric to be manipulated to receive the protrusions of the over centre moulding layer

904.

The over centre moulding layer **904** is, in this embodiment, a continuous silicone rubber sheet having key registration device mouldings protruding on its upper surface. The key registration device mouldings protruding from the upper surface layer **904** are specifically moulded so as to align with the alpha numerical graphical representations shown on the uppermost layer **903**.

There are five layers located in between the first electrically conductive layer **901** and the second electrically conductive layer **902**. A first masking layer **905** and a second masking layer **906** contact the innermost surfaces of the electrically conductive layers **901** and **902** respectively. Both masking layers **905** and **906** are composed of a flexible tear-resistant fabric with a laminate coating of polyurethane applied to one surface of the fabric. In an alternative embodiment, masking layers **905** and **906** are sheets of polyurethane alone without any fabric constituent.

A series of circular holes **915** have been punched through the masking layers **905** and **906**. Each of these holes is located so as to align with a corresponding key registration device moulding **916** of layer **904**. During the use of the keyboard, the masking layers prevent electrical contact occurring between the central conducting layer **907** and either of the outer conducting layers **901** and **902**, except at locations which correspond to keys. Therefore, accidental compression of the keyboard at locations between the keys does not affect the operation of the keyboard.

Located in between the masking layers **905** and **906** are insulating mesh layers **908** and **909**. The insulating layers **908** and **909** are woven or knitted with a relatively wide spacing between fibres so that the conductive

layers are separated while at the same time allowing conduction to take place between the conducting layers when mechanical pressure is applied. The presence of these insulating layers ensures that the overall construction may be folded and flexed or wrapped around objects without causing the two conductive layers to be brought into electrical contact and thereby producing an erroneous contact identification.

Located between the insulating mesh layers **908** and **909** is a central conductive layer **907** which is configured to conduct an electric current from the first electrically conductive fabric layer **901** to the second electrically conductive layer **902** (ie in the Z-axis direction) whilst preventing lateral current flow along the plane of the sheet (i.e. in the X and Y axis directions).

The central conductive layer **907** is constructed by knitting a polyester yarn of twenty-four decitex filaments having a single conductive filament twisted therein, such that the conductive filament appears relatively randomly in the completed knitted product. In addition, the central conductive layer **907** has a conductance perpendicular to the plane of the device (in the Z-axis) that increases as it is placed under pressure thereby facilitating conduction between the layers during a mechanical interaction.

A final fabric layer **917** forms the under surface of the fabric keyboard and, in the present embodiment, also forms the external surface when the device **102** is in the wrapped configuration. This layer is preferably a durable fabric cover configured to provide protection to the inner encapsulated layers of the fabric keyboard. In an alternative embodiment, the under surface of layer **917** is laminated with patches of rubber to provide a high co-efficient of friction between the keyboard and

any surface onto which the keyboard is placed.

The ten layers forming the fabric keyboard are mechanically secured together by an adhesive provided around the perimeter edges of the constituent fabric layers.

Figure 10A

The first electrically conductive fabric layer **901** is shown in more detail in *Figure 10A*. Two conductive tracks **911** and **912** form the electrical contacts with the conductive fibres of fabric layer **901**. A contacting portion **1011** of conductive track **911** contacts the left edge of fabric layer **901**. A conduction portion **1021** of conductive track **911** is channeled into the flexible cable **1017** and prevented from contacting the electrically conductive fabric layer **901** by insulation strip **1001** that runs along the upper edge of fabric layer **901**, and shown as a shaded area in *Figure 10A*.

Similarly, the conductive track **912** contacts the electrically conductive fabric along the right edge of fabric layer **901** over a contacting portion **1021**. A conduction portion **1022** extends into flexible cable **1017** and is prevented from contacting the electrically conductive fabric layer **901** by insulation strip **1001** that runs along the upper edge of fabric layer **901**. This enables voltages to be applied between the conductive tracks **911** and **912** to provide a voltage gradient in the X-axis direction.

Figure 10B

The second electrically conductive layer **902** is shown in more detail in *Figure 10B*. Electrical connection is formed with the fabric layer **902** by the two conductive tracks **913** and **914**. Conductive track **913** forms an

electrical contact with the top edge of the electrically conductive fabric **901** via contacting portion **1013**. A conduction portion **1023** of conductive track **913** extends over insulation strip **1002** that extends along the top edge of the fabric layer, and enters the flexible cable **1017**. Conductive track **914** forms an electrical connection with bottom edge of the fabric sheet **902** via its contacting portion **1014**. A conduction portion **1024** of conductive track **914** extends along the right edge of the fabric sheet and the top edge of the fabric sheet and enters into the flexible fabric cable **1017**. The conduction portion **1024** of conductive track **914** is electrically insulated from the fabric layer by insulating strips **1002**, which extends along the top edge, and **1003**, which extends along the right edge, of layer **902**.

Accordingly, voltages may be applied between the conductive tracks **913** and **914** so as to provide a voltage gradient across the electrically conductive fabric layer **902** from top to bottom in the Y-axis direction.

In this embodiment, only four connections are possible to the fabric keyboard, two connections to conductive tracks **911** and **912** of fabric layer **901**, and two connections to conductive tracks **913** and **914** of fabric layer **902**.

Figure 11

The interface circuit **1103** located in the hand-held processor engaging portion of the self-erecting stand assembly **501** is detailed in *Figure 11*. The interface circuit comprises a peripheral interface controller (PIC) **1102** which is connected to a serial communication output **1103** and electrical connections **1104**, **1105**, **1106** and **1107** configured to supply and receive the necessary voltages to the conductive tracks **911**, **912**, **914** and

913 respectively. The PIC is powered by the hand-held processor device which, in the case of a Palm^{RTM} Vx Processor is within the region of 3.7 to four volts. Four volts will be referred to hereinafter in the description.

The PIC **1102** is a programmable controller of the type PIC16C711. The PIC **1102** operates under the control of a program which controls the parameters of the keyboard which the interface circuit **1103** is configured to measure. Parameters under investigation will be discussed further in reference to *Figures 12* to *16*.

Under control of the PIC **1102**, the necessary output voltages can be supplied to electrical connections **1104**, **1105**, **1106** and **1107** via pins one, two, ten, eleven, twelve and thirteen of the PIC. The PIC includes an analogue to digital converter which is used to process analogue voltages received at pins seventeen and eighteen. The input pins seventeen and eighteen receive outputs from high impedance buffers **1108** and **1109** respectively. The buffers **1108** and **1109** are half of unity gain operational amplifiers of the type TL062, and provide a high impedance buffer between the sensor output voltages and the PIC **1102** input ports.

Connection to pins one and two occurs via resistors **1110** and **1111** respectively. Resistors **1110** and **1111** are selected according to the resistance of the keyboard as measured from a conducting track attached to one fabric layer **901** to a conducting track attached to the second fabric layer **902** while a typical mechanical interaction pressure, ie a key-press is applied. A value of 10Kohms is typical for resistors **1110** and **1111**.

The PIC **1102** has an external crystal oscillator (not shown) running at four MHz connected across pins fifteen and sixteen. Positive four volts is supplied to pin fourteen and ground is connected to pin five. Pin four (the

internal reset input) is held at positive four volts via a series resistor of one hundred ohms.

The PIC **1102** is programmed to supply and receive the necessary voltages to the conductive tracks **911**, **912**, **914** and **913** of the conductive layers **901** and **902**. By this means the interface circuit is able to determine a measure, denoted by Z, of the pressure applied to the keyboard, and if this value is sufficiently large the interface circuit interprets this as a key-press. When a key-press is detected the interface circuit performs a measurement of the X and Y location of where the pressure is being applied. The PIC is further configured to supply data to the output serial port **1103** relating to the position of key-presses detected or the absence of a key-press.

Figures 12A, 12B, 12C and 12D

An overview of the measurements made by interface circuit **1103** is illustrated by *Figures 12A*, *12B*, *12C* and *12D*. The outer conductive layers **902** and **901** are represented schematically by potentiometers **1201** and **1202** and the resistance of the conductive path between the outer layers at the location of the applied force is represented by variable resistor **1203**.

A first measurement is shown in *Figure 12A*. Four volts are applied to connector **1104**, while connector **1105** remains disconnected. Connector **1107** is connected to ground via a resistor **1111** of known value. Thus, current flows from connector **1104** through a first part of layer **901** indicated by a first part **1205** of potentiometer **1202**, through the conductive path indicated by variable resistor **1203** having resistance Rv, through a first part of layer **902**, indicated by a first part **1206** of potentiometer **1201** and

through the known resistor **1111**. The voltage, V1 appearing at connector **1107** is measured and since this is equal to the voltage drop across resistor **1111**, V1 is directly proportional to the current flowing from connector **1104**.

A second measurement is shown in *Figure 12B*. Four volts are applied to connector **1106**, while connector **1107** is disconnected. Connector **1105** is connected to ground via a resistor **1110** of known resistance. The voltage V2, dropped across resistor **1110** is measured. Voltage V2 is directly proportional to the current flowing through a second part of layer **902** indicated by a second part **1208** of potentiometer **1201**, through the conductive path indicated by variable resistor **1203** having resistance Rv, through a second part of layer **901** indicated by a second part **1209** of potentiometer **1202** and through resistor **1110**.

The sum of the resistance of first part **1206** and second part **1208** of potentiometer **1201** is approximately equal to the resistance between contacting portions **1013** and **1014** on layer **902**, and is therefore substantially constant during the measurements, since they occur in rapid succession. Similarly, the sum of the resistance of first part **1205** and second part **1209** of potentiometer **1202** is approximately equal to the resistance between contacting portions **911** and **912** on layer **901**, and is also substantially constant during the measurements. As a result, the relationship **1210** exists between the resistance Rv, of the conductive path between the outer layers, and the measured voltages V1 and V2, ie the resistance Rv between the outer layers is proportional to the sum of the reciprocal of voltage V1 and the reciprocal of voltage V2.

In general, depending upon the type of position sensor used, the resistance Rv depends upon area of the applied pressure or a function of

the area and the force as illustrated by relationship **1211**. Thus, from the voltage measurements V1 and V2 a measure which is dependent on the force applied to the keyboard is determined.

A third measurement is shown in *Figure 12C*. Four volts is applied to connector **1105** while connector **1104** is grounded, and so a potential gradient is produced across layer **901**. A voltage measurement is made at connector **1107**. Since the interface circuit makes use of the high impedance buffer **1108**, the voltage appearing on layer **902** at the position of the applied force is determined. This voltage, V3 is directly proportional to the distance of the centre of the applied force from contacting portion **911** and indicates its X-axis position.

A fourth measurement is shown in *Figure 12D*. Four volts are applied to connector **1107** and connector **1106** is grounded. A voltage measurement is made of voltage V4 appearing at connector **1105**. Voltage V4 is directly proportional to the distance of the centre of the applied force from contacting portion **414** and indicates its Y-axis position. Therefore, voltage V3 and V4 provide information as to the two-dimensional position of the applied force on the sensor, i.e. voltages V3 and V4 represent X and Y values for the centre of the position of the applied force, representing a key-press.

Figure 13

The program running within the peripheral interface circuit of *Figure 11* is outlined in the flow chart of *Figure 13*. At step **1301** the hardware is initialised and this process is detailed later with reference to *Figure 14*. At step **1302** the circuit **103** measures values of voltages V1 and V2 and

calculates a Z value of the interaction. The details of step **1302** are described later with reference to *Figure 15*. At step **1303** a question is asked as to whether the Z data is greater than a predetermined value. If the answer to this question is no then the program returns to step **1302**. Thus the circuit measures Z values until a Z value greater than a predetermined value is detected. If the answer to the question at step **1303** is yes then the circuit measures voltages V1, V2, V3 and V4 and calculates a Z value at step **1304**. Step **1304** is described later in more detail with reference to *Figure 16*. At step **1305** a question is asked as to whether the calculated Z value is still above the predetermined value. If the answer to the question is yes, a further question is asked at step **1306** as to whether enough samples have been obtained. Typically, between three and ten sets of samples are taken, with lower numbers of sets of samples being taken when a fast response time is required. If the answer to the question at step **1306** is no then the program returns to step **1304** and a further set of measurements are made. When the answer to the question at step **1306** is yes, or when the answer to the question at step **1305** is no, then the program calculates average values of the samples of the voltages V3 and V4, and of the values of Z which have been collected. Thus, the program measures a predetermined number of voltages before finding the average values, or if the Z value drops below a predetermined value, the average values are calculated immediately. By using the average of a number of samples the effect of mains power electromagnetic interference or other such environmental noise may be minimised.

A simple calculation to find an 'average' value for say the X value, is to find the median of the maximum and minimum values of the stored

values V3, ie a 'smoothed' value for X is found by adding the maximum stored value of V3 to the minimum stored value of V3 and dividing the result by two.

To further improve accuracy, values of X, Y, and Z that differ by a large amount from their immediately preceding and immediately subsequent values are excluded from the calculations of the average. In addition, known methods of eliminating mains electricity supply interference may be applied to the signals received from the sensor.

At step **1308** the averaged values for V3 and V4 representing X and Y positional co-ordinates and the averaged values of the Z data are output at the serial communication output **1601**. The program then returns to step **1302** and looks for an indication of further mechanical interaction.

Figure 14

Step **1301** of *Figure 13* is shown in further detail in *Figure 14*. Within the initialisation step **1301**, at step **1401** the interrupts are cleared and then at step **1402** pins seventeen and eighteen are set up as analogue to digital converter inputs. The micro ports of a PIC16C711 may be configured as low impedance outputs or high impedance inputs. When in high impedance input mode, pins seventeen and eighteen can be programmed to connect via an internal multiplexer, to the analogue to digital converter. At step **1403** the ports which are to be used as inputs or outputs are configured in their initial state. At step **1404** all system variables are cleared and all interrupts are disabled.

Figure 15

Step **1302** of *Figure 13* is shown in further detail in *Figure 15*. Within step **1302**, at step **1501**, the ports corresponding to pins two and ten are reconfigured as output ports and at step **1502** pin two is set to zero while pin ten is set to positive four volts. Thus connector **1107** is grounded via resistor **1111** and four volts are applied to connector 1104. At step **1503** a time delay (typically of two hundred microseconds in a sensor measuring ninety millimetres by two hundred and forty millimetres with an outer layer resistance of 3.5Kohms) is provided to allow voltages to settle before the voltage at pin seventeen is measured and stored at step **1504**. Thus voltage V1 present at connector **1107** is measured and stored.

At step **1505** pins two and ten are reconfigured as high impedance inputs while pins one and twelve are reconfigured as low impedance outputs. At step **1506** the voltages on pins one and tweve are set to zero and positive four volts respectively. Thus, connector **1105** is grounded via resistor **1110** while four volts are supplied to connector **1106**. A suitable time delay, equivalent to that at step **1503**, is provided at step **1507** before the voltage at pin eighteen is measured and stored at step **1508**. Thus, the voltage present on connector **1105** is measured and stored as voltage V2. At step **1509** a Z value is calculated from stored voltages V1 and V2, and then stored. The pins one and twelve are reconfigured back to their initial state of high impedance inputs at step **1510**.

Figure 16

Step **1304** of *Figure 13* is shown in further detail in *Figure 16*. Within step **1304**, at step **1601** a Z value is collected in the same manner as at

step **1302**. At step **1602** pins one and two are reconfigured as high impedance inputs and pins ten and eleven as low impedance outputs. At step **1603** pin ten is set to zero volts and pin eleven is set to positive four volts. Thus, four volts are supplied to connector **1105** while connector **1104** is grounded. A delay is then provided at step **1604**, (of typically two hundred microseconds for a device measuring ninety millimetres by two hundred and forty millimetres) to allow voltages in the sensor to settle before the voltage on pin seventeen is measured at step **1605**. Therefore, a voltage V3 present on connector **1107** is measured which provides an indication of the X position of the applied force.

Pins ten and eleven are then reconfigured as high impedance inputs and pins twelve and thirteen are reconfigured as low impedance outputs at step **1606**. The voltage on pin twelve is then set to zero while the voltage on pin thirteen is set to four volts at step **1607**. Thus, four volts are supplied to connector **1107** while connector **1106** is grounded. A time delay is provided at step **1608**, similar to that at step **1604**, before the voltage appearing at pin eighteen is measured at step **1609**. Thus, a voltage V4 present on connector **1105** is measured which provides an indication of the Y position of the applied force. Pins twelve and thirteen are then reconfigured back to their initial state of high impedance inputs.

Therefore, by the method described with reference to *Figures 13* to *16* the interface circuit is able to make voltage measurements V3 and V4 which provide an indication of the position of the force applied to a fabric sensor, and measure voltages V1 and V2 which are proportional to currents passing through the sensor and provide information as to a second characteristic of the applied force. The second characteristic may be the

pressure with which the force is applied, or a combination of the size of the force and the area. Furthermore, the circuit combines the voltages V1 and V2 to determine a Z value representative of the second characteristic.

The circuit **503** provides output data representative of X and Y position of the applied force and the Z value. However, in an alternative embodiment the interface circuit provides output data corresponding to the measured voltages V1, V2, V3 and V4.

Figures 17A and 17B

The process by which the electrically conductive layers **901** and **902** form an electrical contact following the depression of a key is shown in *Figures 17A* and *17B*. The fabric keyboard **202** is shown in cross section through a key registration device **303**. *Figure 17A* shows an illustration of key **303** in the absence of a mechanical interaction. The key registration device **303** is moulded into the silicone rubber over centre moulding layer **904**. Located underneath the over centre moulded layer **904** is, in order of occurrence, the first electrically conductive fabric layer **901**, the first mask layer **905**, the first insulating mesh layer **908**, the central conductive layer **907**, the second insulating mesh layer **909**, the second mask layer **906**, the second electrically conductive fabric layer **902**, and the lower fabric layer **917**. In contact with the upper surface of the over centre moulding layer **904** is the upper fabric layer **903**. A graphical representation of the letter, numeral or function to which the key registration device **303** corresponds is printed onto the upper surface of fabric layer **903** to directly coincide with the centre of the key registration device protrusion **303**. The lower surface of the key registration device protrusion **303** has a contact protrusion **1702**

extending towards the electrically conductive layer **901**.

An operator's finger **1701** is shown in *Figure 17A* forming an initial contact with the upper surface of the key registration device protrusion **2601**. Pressure is applied by the finger **1701** to the key registration device protrusion **303** causing the key registration device to flex in a downward direction towards the first electrically conductive layer **901**. as shown in *Figure 17B*. The contact protrusion **1702** mechanically compresses the first electrically conductive layer **901** into close contact with the first mesh layer **908** the central conductive layer **907**, the second mesh layer **909**, and the second electrically conductive fabric layer **902**. It can be seen from *Figure 17B* that the key registration device **303** and the associated contact protrusion **1702** are specifically aligned so as to facilitate a mechanical interaction bringing the electrically conductive layers closer together at region **1703** through a hole in the first and second masking layers **905** and **906**. It should also be noted that the depression of the key registration device by the operators' finger and the resultant bend portions **1704** and **1705** provide tactile feedback to the operators' finger indicating that the appropriate key on the fabric keyboard has been pressed.

The result of the mechanical interaction forcing the first electrically conductive layer **901** and the second electrically conductive layer **902** into close contact is that a voltage applied to either layer will result in a current flowing from one layer to another and enable electrical measurements to be made and the positional co-ordinates of the mechanical interaction to be determined as previously described. The positional co-ordinate data is supplied to the hand-held processor via the interface circuit. The hand-held processor subsequently correlates the X and Y positional co-ordinate data

obtained at the point of the mechanical interaction with a series of look-up tables so that the corresponding data input function corresponding to the key pressed can be determined.

In this regard, the insulating masking layers **905** and **906** limit the areas within which a mechanical interaction may result in a current flowing between the first and the second electrically conductive layers **901** and **902**. Accordingly, an output will only be sent to the hand-held processor when a key is pressed and not following an accidental mechanical interaction at a point on the keyboard other than a key registration device. Therefore, the masking layers **905** and **906** prevent the transmission of ambiguous X and Y positional co-ordinate data correlating to positions around the pre-selected key registration devices and resulting in the correlation with a data input from the look-up table in response to an accidental mechanical interaction within the region around a key registration device.

Figure 18, 19 and 20

Figure 18 shows a further embodiment of the device **102** in a wrapped configuration. A hand-held processor **201**, such as a Palm^{RTM} VX processor manufactured by Palm Inc. is enveloped by a fabric keyboard **202**. The fabric keyboard **202** of the present embodiment is divided into three separate portions by the bends formed in the fabric keyboard, namely a first bend **1805** formed along a first axis and a second bend on **1806** formed along a second axis. In the present embodiment, the first and second axes are disposed in a substantially parallel relationship to one another.

A first lateral portion **1801** contacts the back of the hand-held processor device **201** to form the rear protective cover. The first lateral portion **1801** extends through bend **1805** to the central portion **1802**. The central portion **1802** further extends through bend **1806** to the second lateral portion **1804** which, in the wrapped configuration, contacts the front surface of the hand-held processor device **201**. Hence, a protective cover is formed around the hand-held processor device **201** in the wrapped configuration by the first lateral portion which covers the rear of the device and the central and second lateral portions which form the front protective cover. The front protective cover and the rear protective cover are secured in position by the elastic strap **1803**.

The first stage in un-wrapping the device **102** is to release the elastic strap **1803** by sliding the strap over the top of the device **102**, as shown in *Figure 19*.

Once the elastic strap **1803** has been released the front cover formed by central portion **1802** and second lateral portion **1804** can be folded back to reveal the front face of the hand-held processor device **309**. This configuration of the device is known as the intermediate configuration and is as shown in *Figure 20*. The front surface of the hand-held processor device **309** functions as the operator interface by which the operator can interact with the device by selecting icons on the screen **310** using the stylus **401**, as shown in *Figure 20*, or alternatively further functions may be selected using the interface buttons such as **311**.

As in the previous embodiment, in the intermediate configuration the hand-held processor **309** is conveniently supported in the operators' hand **402**. Accordingly, if the operator only wishes to use the hand-held

processor alone (i.e. and not use the fabric keyboard **202**) it is only necessary to unwrap the device **102** to the intermediate configuration in which the device may be conveniently held in one hand leaving the other hand free to interact with the user interface of the hand-held processor device.

Figure 21

Alternatively, if the operator should wish to use the fabric keyboard in conjunction with the hand-held processor device it will be necessary to re-configure the device into the operational configuration. To re-configure the device to the operational configuration, the front cover of the device **102** can be unfolded along the second bend **1806** as shown in *Figure 21* to reveal the keys of the keyboard that reside on the internal surfaces of the central and second lateral portions. In this transitional state, as shown in *Figure 21*, the central portion **1802** and the second lateral portion **1804** are unfolded and ready for use as a keyboard. The first lateral portion **1801** remains concealed behind the hand-held processor device **309**.

To complete the re-configuration of the device to the operational configuration, the hand-held processor device **309**, as shown in *Figure 21* is removed from the first lateral portion, where it is releasably secured, and connected to the interface circuit connection port **2101** shown centrally located on the upper edge of the central portion **1802**.

Figure 22

The device is shown in the operational configuration in *Figure 22*. In this configuration, the entire keyboard surface (i.e. the first lateral portion

1801, the central portion 1802 and the second lateral portion 1804) are accessible and accordingly, an operator may press any of the keys present on the keyboard surface. Loop strips 2201 and 2202 are shown located on the internal surface of the first portion of the keyboard 202. These loop strips are configured to engage with corresponding hook strips attached to the rear surface of the hand-held processor device 309 to releasably secure the processor device to the keyboard as shown in the previous *Figures 18* to *21*.

In the operational configuration, the hand-held processor device 309 is supported on a surface in a central and elevated position relative to the keyboard 202. The processor device 309 is supported in the elevated position by a support leg (not shown). The keyboard 202 is connected to the hand-held processor device via the interface circuit and the serial input ports of the hand-held processor device 309 as previously described. The operator, therefore, can press keys on the surface of the keyboard 202 to input the corresponding alpha numerical data into the hand-held processor device 309 and view the data entries on the screen 310.

When the operator has finished using the keyboard 202 the hand-held processor device can be disconnected from the keyboard and re-attached via its rear surface to the first lateral portion 1801. The processor device 309 is secured into this position by the engagement between hook strips on the rear of the processor device 309 and the corresponding loop strips 2201 and 2202 located on the surface of the fabric keyboard 202. The second lateral portion 1804 is then folded at 1806 to cover the central portion of the keyboard 1802. In this position, the device has been re-configured into the intermediate position as described in reference to *Figure*

20. The central portion **1802** is then folded over at **1805** to form the front cover of the hand-held processor device **309**. The front and rear covers so formed of the device **102** are subsequently secured together in the wrapped configuration by the elastic strap **1803**.

Figure 23

A further embodiment of the present invention is shown in the operational configuration in *Figure 23.* As described in reference to the previous two embodiments, the fabric keyboard **2302** shown in *Figure 23* is connected to the hand-held processor device **309** via the interface circuit **2303**, flexible fabric cable **2305** and the serial interface provided on the rear bottom end **401** (not shown) of the hand-held processor. In this embodiment the hand-held processor **309** is a Palm^{RTM} III processor manufactured by Palm Inc. The connecting strip **2305** provides a mechanical connection between the keyboard and the hand-held processor. The interface circuit, as previously described, provides power to the fabric keyboard **2302** and determines outputs from the fabric keyboard in a manner described in reference to *Figures 11* to *16.* A slight modification to the operation of the keyboard is required given that power for the operation of the keyboard is derived from the hand-held processor which, in this embodiment provides 3.3 volts, with the previous embodiments operating on 3.7 to four volts derived from the Palm^{RTM} Vx processor.

In the operational configuration, the alpha numeric characters of the keyboard **2302** are accessible to the operator and data input entries produced by pressing a key are displayed to the operator via the screen **310** of the hand-held processor **309**.

The keyboard **2302** of the present embodiment differs from that of the previously described embodiments in that the silicone rubber moulded key registration device layer **904** is absent. Accordingly, the keys do not have any elevation from the keyboard surface in the embodiment shown in *Figure 23*. This has the advantage that the keyboard **2302** is of reduced thickness to the keyboard **202** which allows for a more compact device in the wrapped configuration and less steric hindrance on bending, but has the disadvantage in that no tactile feedback occurs on depressing a key and some protective cushioning capacity may be lost by omitting the silicone rubber moulded key registration layer. Therefore, in an alternative embodiment the fabric keyboard **2302** comprises a silicone rubber moulded key registration layer such as the layer **904**.

The application of a mechanical pressure to keyboard **2302** results in the identification of the position of the mechanical interaction by the interface circuit **2303** as previously described. In this embodiment, however, which uses a Palm^{RTM} III processor as the hand-held processor **309**, the positional data is correlated with look-tables and related to a specific alpha numerical data entry in the PIC processor **1102**. The character representation is then transmitted to the hand-held processor **309**. Therefore, the look-up correlation is performed by the interface circuit **2303** rather than the hand-held processor **309**.

In addition to identifying particular locations corresponding to key-presses, it is also possible to identify gestures, such as the sweeping of a finger across a keyboard in a particular direction. Upon detecting a dynamic movement of this type, the interface circuit **2203** catches this and again converts this into a particular form of data that may be transferred to the

hand-held processor **309**. In the present embodiment, for example, a gesture of this type could be used to shift from lower case to upper case characters. Alternatively, with the keyboard connected to a device such as a mobile phone for example, a gestural movement could indicate to the mobile phone that a call is to be established, equivalent to pressing the send button on most commercially available mobile phones.

In addition to being used as a keyboard, the keyboard **2302** may also perform other functions, similar to those available through use of a mouse or a touch tablet etc. Under this mode of operation, instead of individual regions being identified, movements over the surface of the device are detected and conveyed as positional or vector information to the hand-held processor **309**. A region within the device may be established allowing mode selection. Alternatively, a particular gestural movement, such as a vertical swipe, may be used to indicate a transfer between modes of operation.

Figure 24

In *Figure 24*, the hand-held processor **309** is shown connected to a keyboard **2401** of similar construction to keyboard **2302** but having an alternative means of securing the keyboard in the wrapped configuration. Whereas keyboard **2302** is provided with Velcro strips, keyboard **2401** has press-studs.

The method of wrapping the hand-held processor **309** from the operational configuration to the wrapped configuration in the present embodiment is in *Figures 24, 25* and *26*. In *Figure 24*, the hand-held processor **309** and keyboard **2401** are shown mutually arranged such that

a user may type on the keyboard while observing its screen display **310** which is centrally located relative to the keyboard **2401** and supported in an elevated position relative to the plane of the keyboard. However, when the use of the processing device **309** is no longer required, it is wrapped up in the fabric keyboard **2401**, to form a protective cover for the hand-held processor **309**. The keyboard is provided with press-studs **2410** to **2413** which are fastened to secure the keyboard in place around the hand-held processor **309**.

The hand-held processor **309** is wrapped in the keyboard by firstly bending the flexible fabric cable **2305** such that the hand-held processor **309** is rotated forward as indicated by arrow **2415**, around a first axis indicated by dashed line **2416**. In the present embodiment, flexible fabric cable **2305**, is bent such that the front face **2417** of the hand-held processor **309** lays against a central portion **2420** of the keyboard's upper surface, as shown in *Figure 25*. In an alternative embodiment, the flexible fabric cable is replaced by a hinged mechanism that allows similar folding while providing the electrical data connection between the keyboard **2401** and the processing device **309**.

Figure 25 and 26

Therefore, *Figure 25* shows the fabric keyboard **2401** and the processing device **309** after the first stage of the wrapping process in the intermediate position, and it also shows the connecting strip connected to the hand-held processor **309** by a suitable connector **2501**. A leg **2502** is provided which is connected by means of a hinge to the connector **2501**. The leg is shown in its operating position and it is used to provide a stand

for the hand-held processor **309** to allow the LCD screen to be viewed more easily.

In order to reconfigure the device into the wrapped configuration, the leg **2502** is folded down, so that it is substantially parallel to the rear of the hand-held processor. A first lateral portion of the keyboard **2510** is then bent around a second axis indicated by dashed line **2421**, and at right angles to axis **2416**, so that the first lateral portion **2510** of the keyboard lays against the rear surface **2521** of the hand-held processor **309**. The keyboard is then folded around a third axis **2422**, substantially parallel to the second axis **2421**, so that a second lateral portion of the keyboard **2511** lays against the rightmost part of the rear surface **2521** of the hand-held processor **309**. Thus hand-held processor **309** is wrapped in the keyboard as shown in *Figure 26*, and the press-studs **2412** and **2413** are then fastened to **2411** and **2410** to hold the keyboard in place.

Thus the keyboard **2401** may be arranged in an operational configuration as shown in *Figure 24* and may be reconfigured into a wrapped configuration, as shown in *Figure 26*, by rotating the hand-held processor **309** by folding the connecting means about a first axis **2416**, and then folding the keyboard about a second axis **2421** and a third axis **2422** which are non-parallel with the first axis.

Figure 27

A rear view of hand-held processor **309** (a Palm^{RTM} III processor manufactured by Palm Inc.) is shown in *Figure 27*. The rear of the hand-held processor **309** includes ten electrical connections referred to as pins, such as pins **2702**, **2703** and **2710**. Pin **2702** provides 3.3 volts to the

interface circuit through a three hundred and thirty ohm resistor within the hand-held processor. From the hand-held processor perspective, pin **2703** is the receive data connection, therefore data from interface circuit **2303** is supplied to this pin. Signal ground is provided by pin **2710** and for this particular application the remaining pins are not used.

Figure 28

The keyboard can be used with any portable equipment where data entry is required or is considered desirable. A further example is shown in *Figure 28* in which a flexible keyboard **2401**, is attached to a mobile cellular telephone **2801** via a suitable interface **2803**. Typically, communications interfaces of mobile cellular telephones are responsive to AT commands as is well known in the art. Particular implementation of an interface device **2803** will, however, require modification in order to facilitate connection to a particular mobile phone variety and information may be required from a mobile telephone company in order to fully secure an appropriate link without invalidating warranties.

Increasingly, mobile telephones similar to telephone **2801** are being used for the transmission of text messages, that may be achieved using the second generation GSM standard via the SMS procedure. Text communication is further enhanced by WAP technologies and applications for third generation mobile telephones. Thus, a keyboard of this type becomes particularly attractive when the telephone is being used for e-mail or Web browsing. Thus, a relatively small telephone can be given functionality substantially similar to that provided by more sophisticated models, such as the Nokia Communicator 9000.

Figure 29

Figure 29 shows a further embodiment of the present invention in the operational configuration. The keyboard **2901** is identical in structure to keyboard **2401** previously described in reference to *Figure 24*. As before, the surface of the keyboard is graphically divided into a plurality of regions each of which is associated with a particular letter, such as the letter W indicated at **2902**, numeral or similar keyboard button function. The keyboard **2901** is secured to a hand-held electronic processing device **309** which, in this example, is a Palm IIIe manufactured by Palm Inc. The keyboard is secured to the hand-held device **309** by clamping a short portion of the keyboard between the two halves of the case of the hand-held device.

An advantage of the arrangement shown in *Figure 29* is that the keyboard remains permanently connected to the electronic processing device and is therefore always available for an operator to use when making operations where it is preferable for a manual keyboard to be available. In addition, whilst being transported, the keyboard adds very little in terms of bulk and is therefore permanently provided without incurring undesirable additional weight and bulk. Furthermore, during transportation the sheets forming keyboard **2901** are arranged to be wrapped around the device **309** thereby minimising the additional bulk associated with the device **309** while at the same time providing a protective cover.

In the operational configuration shown in *Figure 29* an operator can access all the keys on the surface of the fabric keyboard. When not in use, however, such as during transportation, the fabric keyboard **2901** can be

reconfigured into the wrapped configuration as shown in *Figure 30*. The *fabric keyboard is first extended over the surface of the hand-held* processor **309**, around a first edge of the device, across the rear of the device and around the opposing second edge of the device.

Figure 30

The fabric sheets are held firmly in place by means of a hoop and loop fastener such as Velcro or similar fastening made up of components **3001** and **3002**.

Figure 31

The electrical connections formed between the fabric keyboard **2901** and the processing device **309** are shown in *Figure 31*. For the purpose of illustration, only the first electrically conductive layers **901** and **902**, and the central conductive layer **907** of the fabric keyboard have been shown. It must be appreciated however, that the device advantageously comprises nine layers as previously described in reference to *Figure 23* or, in an alternative embodiment, comprises the ten layers described in reference to *Figure 9*.

The first electrically conductive layer **901** has first and second conductive tracks **911** and **912** attached thereto as previously described and the second electrically conductive layer **902** has a third conductive track **913** and a fourth conductive track **914** attached thereto, again as previously described. Central conductive layer **907** has previously been described in reference to *Figure 9*. The position of this mechanical interaction is detected as previously described in *Figures 12* to *17*.

The process of measuring X and Y co-ordinates of a mechanical interaction on the keyboard surface is a two-part operation and is substantially similar to that performed within the hand-held processor device 309. Consequently, this provides a relatively straightforward manner for interfacing the keyboard **2901** with the processing device **309**.

The display **310** includes a glass sheet **3121** having an electrically conductive coating applied to its upper surface. This is then held parallel to a transparent plastic sheet **3122** having an electrically conductive coating on its lower surface. The two sheets **3121** and **3122** are held very close together and, as such, a minimal mechanical pressure applied to upper sheet **3122** results in electrical contact being made between the two sheets. The position of this mechanical contact is then determined by using a process substantially similar to that performed in order to determine the position of contact on the fabric keyboard **2901**. Consequently, in the configuration shown in *Figure 31*, the electronics provided for determining the position of a mechanical interaction upon the actual hand-held processor display **310** is exploited to provide a similar mechanical detection process for the fabric keyboard **2901**. The two are therefore connected in parallel such that the electronics of the hand-held processor **309** operate as normal receiving signals via the fabric keyboard **2901** that are substantially similar to signals received from the internal display **310**.

The resistance of conductive sheet **901** in the X direction, between conductive tracks **911** and **912**, is typically 5K57 Ohms. Similarly, the resistance in the Y direction of sheet **902**, between conductive tracks **913** and **914** is typically 1K36 Ohms. In the particular software used to display a keyboard on hand-held processor display **310**, the on screen keyboard is

positioned substantially at the centre of the display, as indicated by dotted line **3123**. Consequently, signals received from the fabric keyboard **2901** require off-sets in order for the regions representing alpha numeric characters to map onto the position of similar alpha numeric characters displayed in region **3123**. This is achieved by the provision of additional resistors **3131**, **3132**, **3133** and **3134**. Typically, for sheet resistances previously described, resistors **3131** and **3132** have a resistance of 2K Ohms and resistors **3133** and **3134** have a resistance of two hundred and twenty Ohms. Additional processing circuitry of the hand-held processor, that is not modified in any way, is represented generally by box **3150**.

Figure 32

An alternative embodiment to the fabric keyboard **202**, **2401** and **2801**, as previously described, is shown in *Figure 32*. In this embodiment, the keyboard **3201** is a membrane keyboard and is shown in an exploded perspective view in *Figure 32* to illustrate the constituent layers.

The uppermost layer is a silicone rubber moulded layer **904**, identical to that previously described in reference to *Figure 9*. This layer is laminated on the upper surface with a durable fabric layer such as layer **903** (described in reference to *Figure 9*), onto which graphical icons corresponding to the individual keys are printed. In an alternative embodiment, the uppermost layer is laminated with a durable flexible plastic film, such as the polyester or polyvinyl chloride film, onto which the graphics corresponding to each key are printed.

The membrane keyboard **3201** comprises a first electrically conductive membrane film **3202** and a second electrically conductive

membrane film **3203**. In addition, a spacing membrane layer **3204** is positioned in between the first electrically conductive membrane layer **3202** and the second electrically conductive membrane layer **3203**.

The first electrically conductive membrane layer **3202** is a film of Mylar^{RTM} (polyethylene terephthalate). Onto the underside of the film **3202** carbon electrodes (formed from silver-loaded ink), such as **3210**, are printed forming the conductivity of the first electrically conductive membrane. The electrodes are connected to an interface circuit which supplies voltages to the electrodes, such as **3210**, via conductive tracks, such as **3211**. Each electrode is specifically aligned so as to correspond with a key registration device on the layer **904**. For example, the electrode **3210** corresponds to the centre of the 'CAPS LOCK' key **3240**.

The second electrically conductive membrane layer **3203** is also composed of Mylar^{RTM} membrane having silver-loaded ink electrodes such as **3220** printed onto the upper surface which form the electrical conductivity of the second electrically conductive membrane layer. Each of the electrodes printed onto the upper surface of layer **3203** is aligned with a corresponding electrode on layer **3202** and a corresponding key registration device on layer **904**. For example, electrode **3220** on layer **3203** is specifically aligned with electrode **3210** on layer **3202** and the 'CAPS LOCK' key **3240** on layer **904**.

A separator layer **3204** is a non-conductive membrane sheet of Mylar^{RTM} with holes, such as **3230**, located to coincide with the electrodes printed on to the surfaces of layers **3202** and **3203**. For example, the hole **3230** is specifically aligned with the electrode **3210** on layer **3202** and the electrode **3220** on layer **3203**.

The separator layer **3204** prevents an electrical contact occurring between the electrodes of layers **3202** and **3203** unless a mechanical interaction has occurred by pressing a key on layer **904**. For example, the 'CAPS LOCK' key **3240**, when pressed, causes the compression of the electrode **3210** towards the electrode **3220** through the hole **3230** in the separator layer **3204**. In principal the key registration device **3240** is functioning identically to the key registration device **303** as described in reference to *Figures 17A* and *17B*.

Accordingly, if a voltage is supplied to the electrode **3210** via the conductive track **3211**, a press of the 'CAPS LOCK' key will form an electrical contact between the electrode **3210** of layer **3202** and the electrode **3220** of layer **3203**. Therefore, a voltage output is detectable in the conductive track **3221** on layer **3203**. As the depression of the 'CAPS LOCK' key is the only key that would produce a voltage output in conductive track **3221** when a voltage has been applied to the conductive track **3211**, then, by detecting this voltage output, the interface circuit is able to correlate the output with the corresponding electrical connections formed. This data is either correlated with look-up tables in the interface circuit to assign the correlating 'CAPS LOCK' function output with the key press or the look-up table correlation is performed in the hand-held processor following an output of the connections formed and the output detected.

In an alternative embodiment, the membrane layers **3202**, **3203** and **3204** are made of an alternative plastics material such as polyester or polyvinyl chloride.

Figure 33

The electrically conductive membrane layer **3202** is shown in more detail in *Figure 33*. The layer **3202** has a conductive electrode, such as **3210**, for each key of the keyboard and the elongate space bar, in this embodiment, has six corresponding electrodes as indicated at **3320**. Voltages are applied to the electrodes via conductive track **3211** and **3301** to **3313** which are generally arranged to define fourteen columns respectively. The conductive tracks **3211** and **3301** to **3313** extend to form a connection with the interface circuit (not shown). The interface circuit can form a connection independently with each conductive track as will be described later in reference to *Figure 34*.

The second electrically conductive membrane layer **3201** is also shown in *Figure 33*. Each conductive electrode printed on the surface of membrane layer **3203**, such as **3220**, is connected by one of five conductive tracks **3221** and **3330** to **3334**. In contrast to the first electrically conductive layer **3202**, the conductive tracks of the second membrane layer **3203** effectively connects the electrodes to define a series of five rows that extend near perpendicularly to the columns defined by the conductive tracks on layer **3202**. Accordingly, each key, when pressed, will only produce an output in a specific row following the application of a voltage to a specific column defined on layer **3202**. For example, if a voltage is supplied to conductive track **3303** which extends to form connections to the six electrodes corresponding to the space bar key as indicated at **3320**, and the space bar key is depressed, a voltage output will be detectable in conductive track **3330** of layer **3203**. The depression of the space bar key

is the only key that will produce an output in conductive track **3330** when a voltage is supplied to the conductive track **3303**.

There are many alternative configurations that the electrodes and conductive tracks may take to essentially achieve the same function to that shown in *Figure 33*. In one such example of an alternative embodiment, the conductive rows and columns are effectively printed onto the same membrane layer such that at a given position corresponding to a key registration device the printed electrodes of a specific row and column terminate so as to provide an open circuit with electrodes adjacent to each other in the area of a key. In this embodiment however, attached to the underside of each key registration device is a 'pill' of conductive material such as carbon which, when the key is depressed, contacts and bridges the gap between the respective column and row terminal to form a closed circuit. In a similar manner to that described in reference to *Figures 31* and *32*, the detection of an output voltage in a particular row in response to a voltage supplied to a particular column will be indicative of a specific key press.

Figure 34

In order to enable the detection of a key press within an area of the keyboard, the interface circuit is arranged as shown in *Figure 34*. The interface device includes a detection processor **3401**, a pressure/location detection circuit **3402**, a switching circuit **3403**, a multiplex switch **3404** having electrical connection inputs elements **3405**, an input socket **3406** and an output socket **3407** provided to allow connection to a hand-held device **309**.

Each of the five conductive tracks that define five rows on membrane layer **3303** has an individual connection formed thereto and each of the fourteen conductive tracks that define columns of membrane layer **3302** has a connection formed thereto. Consequently there are nineteen connections formed between the interface circuit and the keyboard. The wires corresponding to each connection are fed individually to the input elements **3405** of multiplex switching circuit **3404**.

If a key is pressed on the keyboard, the interface circuit provides an output identifying the location of a mechanical interaction. Voltages are applied to the keyboard through the pressure/location detection circuit **3402** which is essentially the same as the circuit shown in *Figure 11*. The circuit shown in *Figure 11* forms four connections which in the interface circuit of the present embodiment are connected to multiplex switch **3404**. In this embodiment, only two connections of the circuit shown in *Figure 11* are utilised. For example, voltages are applied to the conductive tracks of layer **3302** via connection **1104** and connection **1107** is connected to the conductive tracks of layer **3303** to detect any output voltages. The precise arrangement of the connections formed at any given time is determined by the multiplex switch, under the control of the detection processor. In a first mode of operation, the multiplex switch conducts a sequential scan of each row following the application of a voltage to each conductive column on layer **3302**.

If an output is detected via connector **1107** in response to a key press, the pressure location detection circuit produces an output which is sent via the switching circuit **3405** to the detection processor **3401** where the output is correlated with the precise connection formed and positional

information corresponding to the connections formed and the output received are sent to the hand-held processor via the switching circuit **3405** and the output socket **3407**. In the present embodiment, such data is correlated with look-up tables to determine the corresponding alpha numerical or function input to which the key pressed relates.

In an alternative embodiment, to reduce the number of operations required to determine which key has been pressed and hence increase the speed with which a key press is detected, the multiplex switch **3404**, in an initial state under the control of the detection processor **3401**, connects the pressure/location detection circuit **3402** to all five conductive tracks on layer **3203** and a second connection to all fourteen conductive tracks on layer **3202**. A total of two connections to the pressure location detection circuit **3402** are made. If, on viewing these terminals, an open circuit is present, no mechanical interaction has occurred on the alpha-numeric keyboard. Alternatively, if a closed circuit is identified, this indicates the presence of a mechanical interaction and an output to this effect is supplied to switching circuit **3403** which in turn conveys this information to the detection processor **3401** and to output socket **3407**.

On detection of a mechanical interaction, the multiplex switch **3404** under the control of detection processor **3401**, maintains the connection of the pressure/location detection circuit **3402** to layer **3202**, and a single connection is made from the pressure/location detection circuit **3203** to the leftmost seven of the conductive tracks **3211** and **3301** to **3306** of layer **3202**. Again the pressure/location detection circuit **3402** detects the presence of a closed or open circuit; a closed circuit indicating one or more key presses in the leftmost half of the alpha-numeric keyboard. An output

indicative of an open or closed circuit is supplied to the switching circuit **3403** which in turn conveys this information to the detection processor **3401** and to output socket **3407**.

The multiplex switching circuit is then commanded by the detection processor to disconnect the connection to the seven leftmost conductive tracks of layer **3202** and make connections from the pressure/location detection circuit **3402** to the remaining seven conductive **3307** to **3313** respectively. Again an open or closed circuit is detected and the information relayed to the detection circuit **3401**. A closed circuit at this stage indicates one or more key presses in the rightmost half of the QWERTY keyboard outline.

The connections to the pressure/location detection circuit **3402** are maintained by the detection processor while the pressure location detection circuit provides an output indicative of a mechanical interaction. When a mechanical interaction is no longer indicated, the detection processor returns the multiplex switch back into the initial state.

Alternatively, if one or more key presses are detected relating to either the seven leftmost conductive tracks **3211**, **3301** to **3306**, then the detection processor **3401** performs a binary search to identify the conducting row and column intersection at which a mechanical interaction is present. The circuit does this by a process of elimination. For example, if a key press is not detected in the columns relating to conductive tracks **3307** to **3313** then no further search is necessary in respect of these columns. But, if a key press is detected in the seven leftmost conducting columns relating to conductive tracks **3211** and **3301** to **3306**, the multiplex switch **3404** under the control of detection processor **3401** makes

connections from pressure/location detection circuit **3402** to the first four conductive tracks **3211** and **3301** to **3303** of layer **3202** and a further connection to the five conductive tracks on layer **3203**. Pressure/location detection circuit **3402** detects the presence of an open or closed circuit and provides an indicative output to detection processor **3401**. The multiplex switch **3404**, then makes a connection from pressure/location detection circuit **3402** to the next three attachment portions **3304** to **3306** while maintaining the connections to the five conductive tracks of layer **3203**. The pressure/location detection circuit **3402** detects the presence of an open or closed circuit and provides an indicative output to detection processor **3401**.

Thus, the control circuit identifies if just one or both of the two groups of four columns is subject to a key press. If just one of the two groups is identified as relating to a key press, then this group only is interrogated and the other group is eliminated from further search. But if both groups are identified as relating to a key press, then both groups will need to be interrogated further.

The process of binary search is continued in this manner until the identity of the individual columns relating to the key press or presses is established. A similar process is then followed to establish which of the rows contains the key press or presses. This is done by making connection of the location detection device to all fourteen conductive tracks of layer **3202** and a second connection to a varying number of the conductive tracks of layer **3203**. Having established both the row and the column, the detection processor **3401** then provides an output indicating the location(s) to output socket **3407** via the switching circuit **3403**. The detection

processor then resets the multiplex switching circuit to its initial state in readiness for the next mechanical interaction to be detected.

The membrane keyboard embodiment described in reference to *Figure 32* to *33* may be substituted for the fabric keyboard as described in all the previously described embodiments. Accordingly, the membrane keyboard may be folded in any of the previously described configurations.

Claims

1. A manually operable input apparatus for a portable electronic processing device, defining a plurality of regions each representing a respective data item, said manually operable input apparatus comprising a plurality of sheets configured to produce a response to a mechanical interaction,

wherein said sheets are configured to be wrapped around said device to provide a protective cover.

2. Apparatus according to claim **1**, wherein said input apparatus is a keyboard.

3. Apparatus according to claims **1** or **2**, wherein said processing device is a hand-held computer, a mobile telephone or portable audio equipment.

4. Apparatus according to any of claims **1** to **3**, wherein said apparatus is connected to said electronic processor device by a connection means.

5. Apparatus according to claim **4**, wherein said connection means further comprises an interface circuit configured to apply voltages to one or more of said sheets and to convey positional data to said electronic processing device.

6. Apparatus according to claim 7, wherein said electronic processing device is programmed to correlate said positional information with look up tables for converting positional information received from said interface circuit into a presentation in the form of alpha numeric text.

7. Apparatus according to any of claims 4 to 6, wherein said connections means is configured so as to retain said electronic processing device connected thereto during the bending operations.

8. A manually operable input apparatus according to any of claims 4 to 7 and a portable electronic processing device in combination, wherein said connection means connecting said apparatus to said processing device is foldable to allow said processing device and said apparatus to be mutually arranged in an operational configuration in which said processing device is supported in a position spaced apart from said input apparatus, and to be reconfigured to a wrapped configuration, in which said device is enveloped by said input apparatus, by the steps of

folding said connecting means about a first axis to an intermediate position in which said processor device is received on a surface said apparatus, and

bending said apparatus about a second and a third axis, non-parallel with said first axis.

9. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim 8, wherein said

processor remains connected to said connection means during said folding operations.

10. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **8** or **9**, wherein said second and third axis are disposed in a substantially parallel relationship to one another.

11. A manually operable input apparatus and a portable electronic processing device in combination as claimed in any of claims **8** to **10**, wherein said second and said third bending axis divide the detector into a central portion, a first lateral substantially planar portion and a second lateral substantially planar portion.

12. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **11**, wherein, in the intermediate position, said electronic processor device is received by said central portion and said first lateral portion bends about a first edge of said electronic processor along said second axis and said second portion extends about a second edge of said electronic processor along said third axis to form said wrapped configuration.

13. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **12**, wherein said first and second lateral portion of said apparatus are secured in the wrapped configuration by a securing means.

14. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **13**, wherein said securing means is a loop and hook arrangement such as Velcro.

15. A manually operable input apparatus and a portable electronic processing device in combination as claimed in any of claim **8** to **14**, wherein, in said intermediate position, said processor is operable independently of said input apparatus.

16. A manually operable input apparatus and a portable electronic processing device in combination as claimed in any of claims **11** to **15**, wherein said device is supported on a self-erecting support mechanism in said operational configuration.

17. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **16**, wherein said mechanism comprises a flexible fabric cable having electrical connection elements contained therein and sections of a supporting plastic.

18. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **17**, wherein said sections of supporting plastic are hinged to facilitate self-erection of said support.

19. A manually operable input apparatus and a portable electronic processing device in combination as claimed in claim **18**, wherein said sections of plastic hinge about said plastic cable.

20. A manually operable input apparatus according to any of claims **1** to **7** and a portable electronic processing device in combination, wherein said apparatus is permanently attached to an edge of said processor device and configured to allow mutual arrangement in an operable configuration, in which the input apparatus extends from said edge of said processor, and reconfiguration into a wrapped configuration in which said input apparatus is wrapped around said processor device.

21. A manually operable input apparatus and a portable electronic processing device in combination as claimed in any of claims **2** to **25**, wherein said input apparatus is constructed from fabric.

22. A manually operable input apparatus and a portable electronic processing device in combination as claimed in any of claims **2** to **25**, wherein said input apparatus comprises a membrane keyboard.

23. A manually operable input apparatus and a portable electronic processing device in combination as claimed in any of claims **2** to **25**, wherein said keyboard surface is configured so as to facilitate the bending of the keyboard.

24. A manually operable input apparatus for a portable electronic processing device, defining a plurality of regions each representing a respective data item, said manually operable input apparatus comprising a at least one fabric sheet and at least one membrane sheet, said sheets being configured so as to produce an output in response to a mechanical interaction,

wherein said sheets are configured to be wrapped around said device to provide a protective cover.

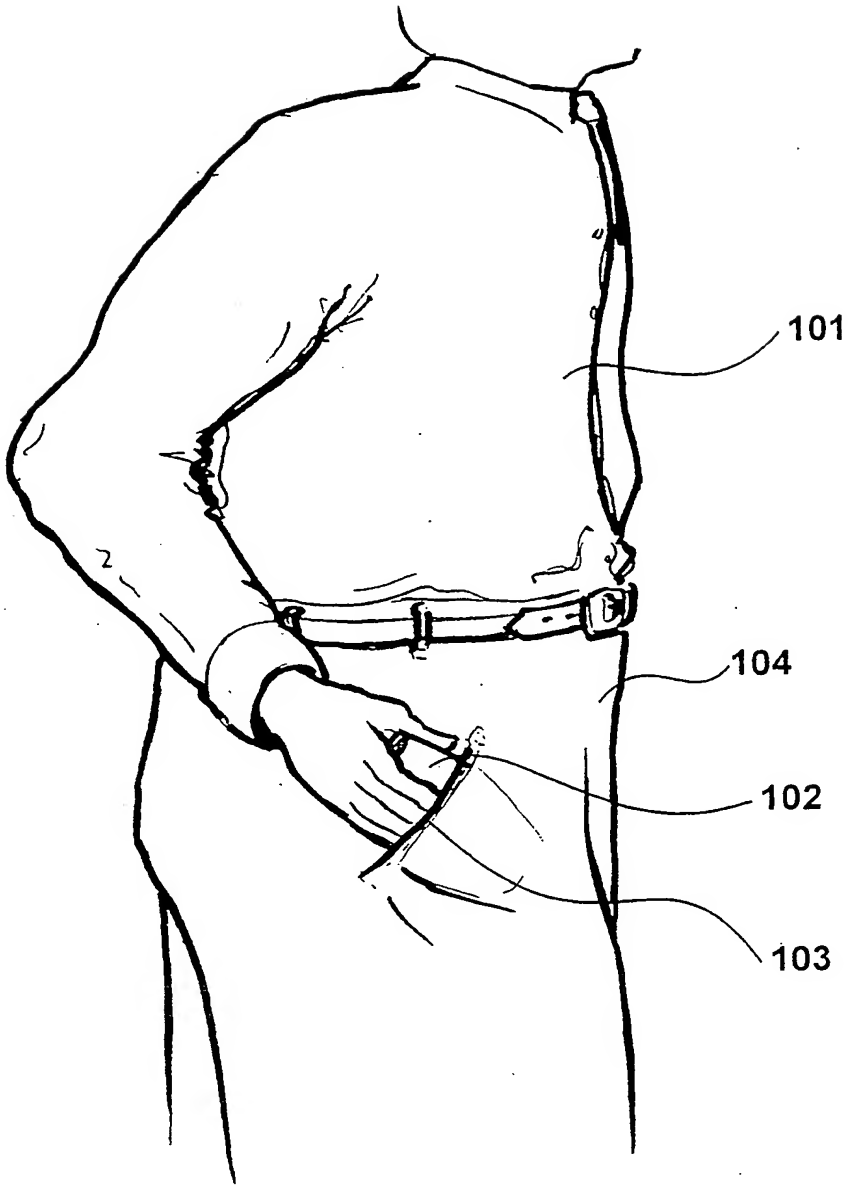

Figure 1

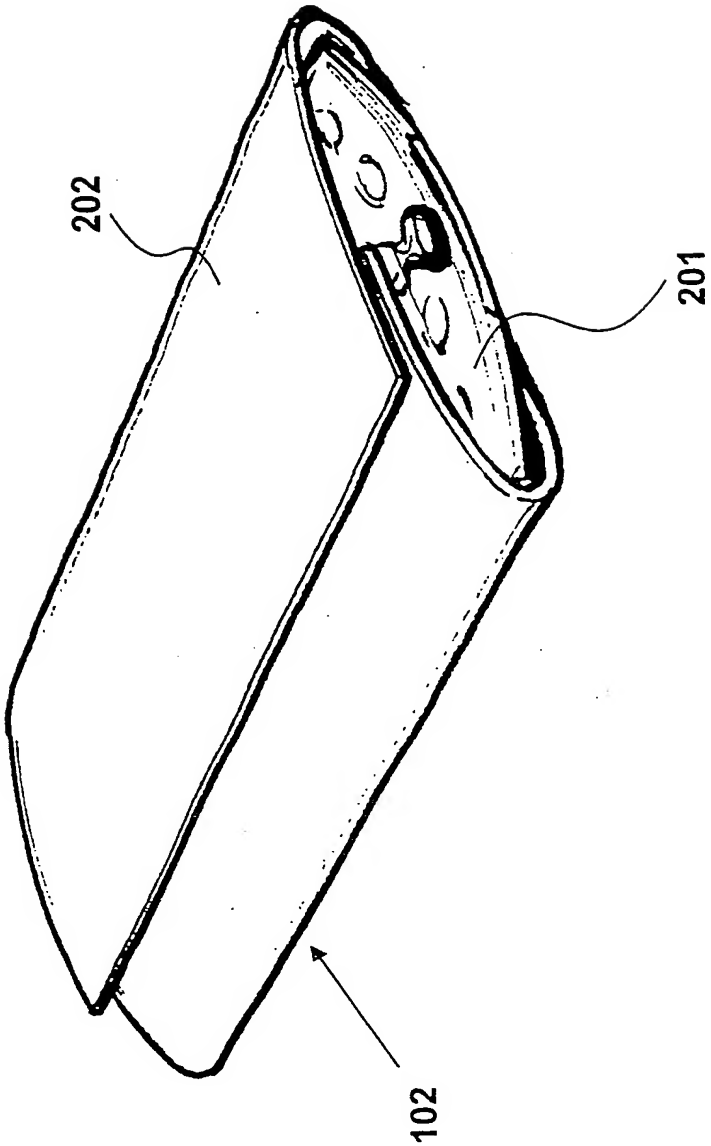

Figure 2

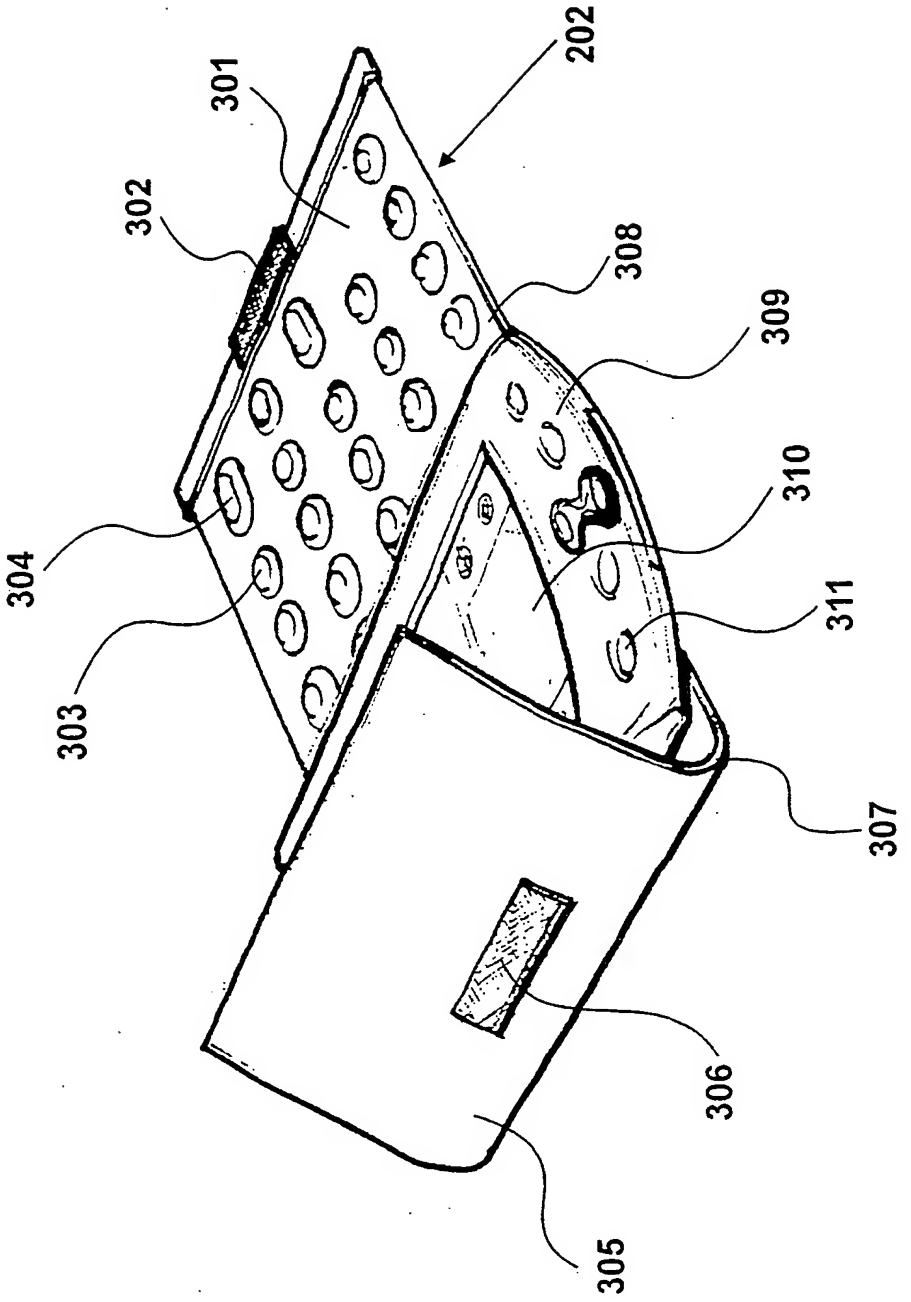

Figure 3

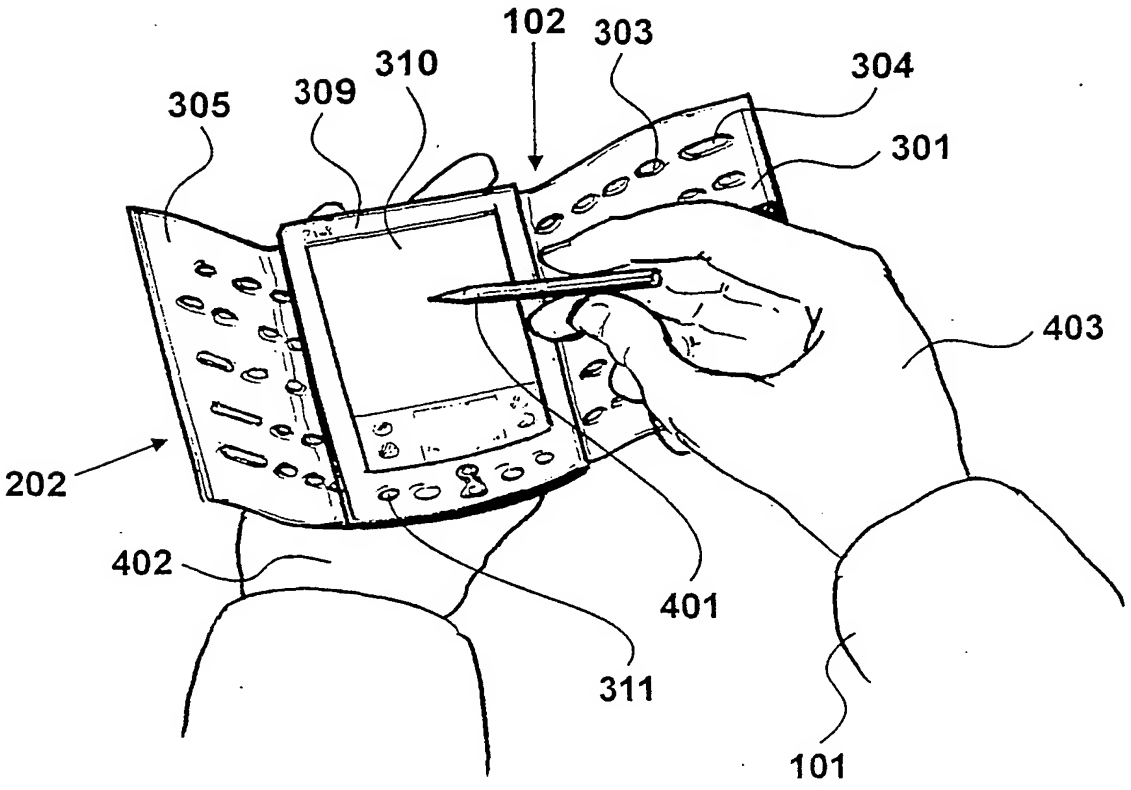

Figure 4

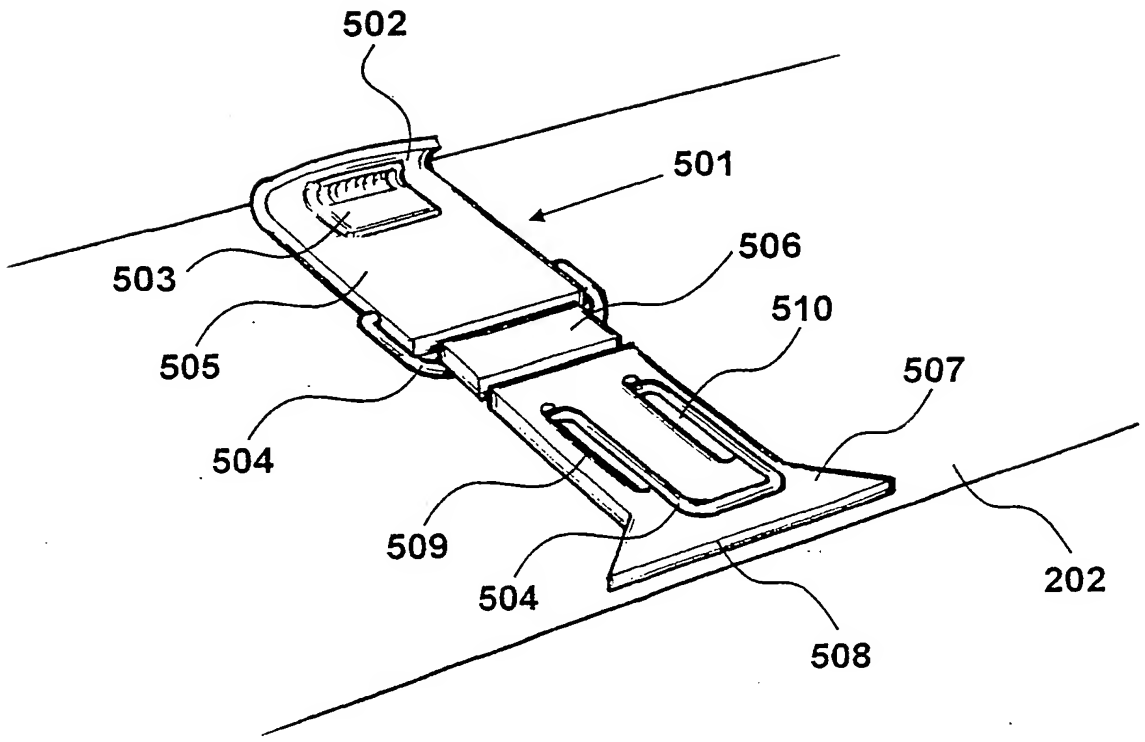

Figure 5

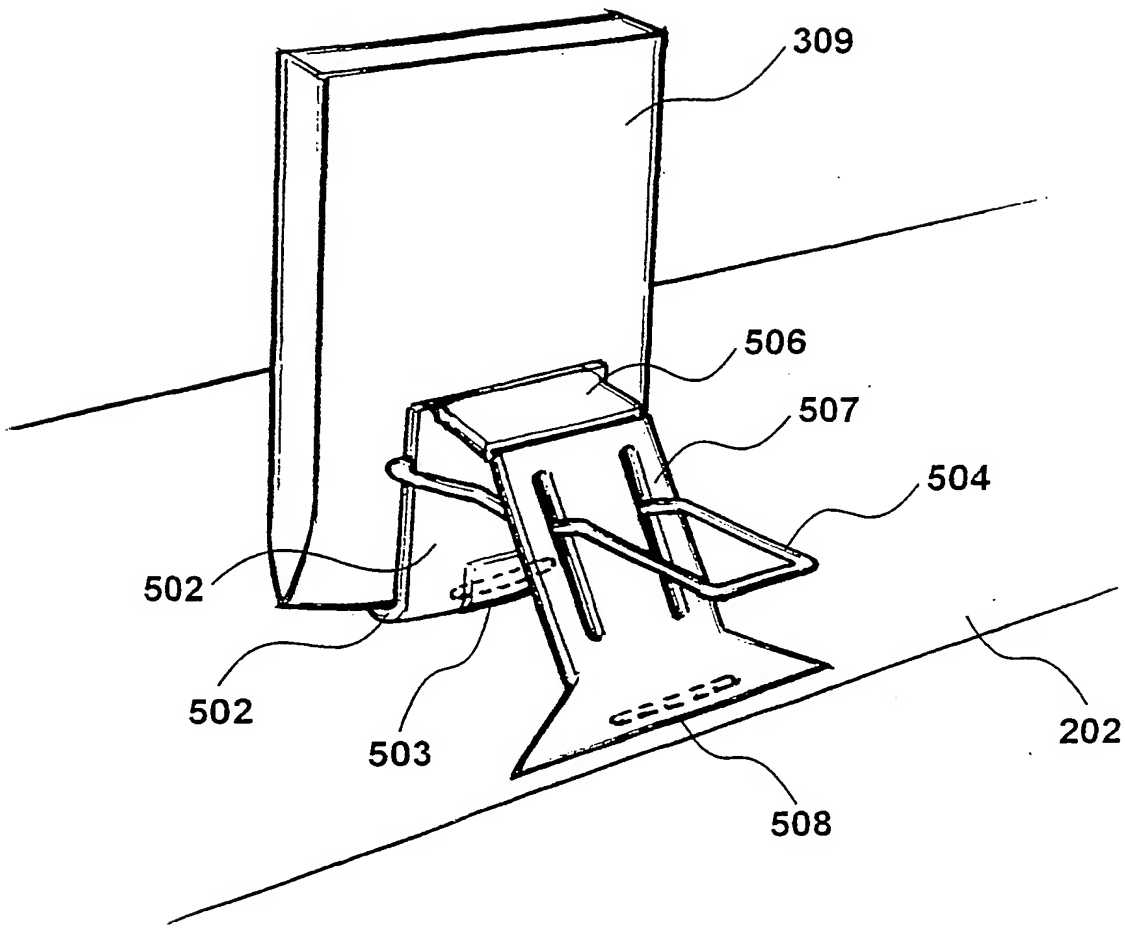

Figure 6

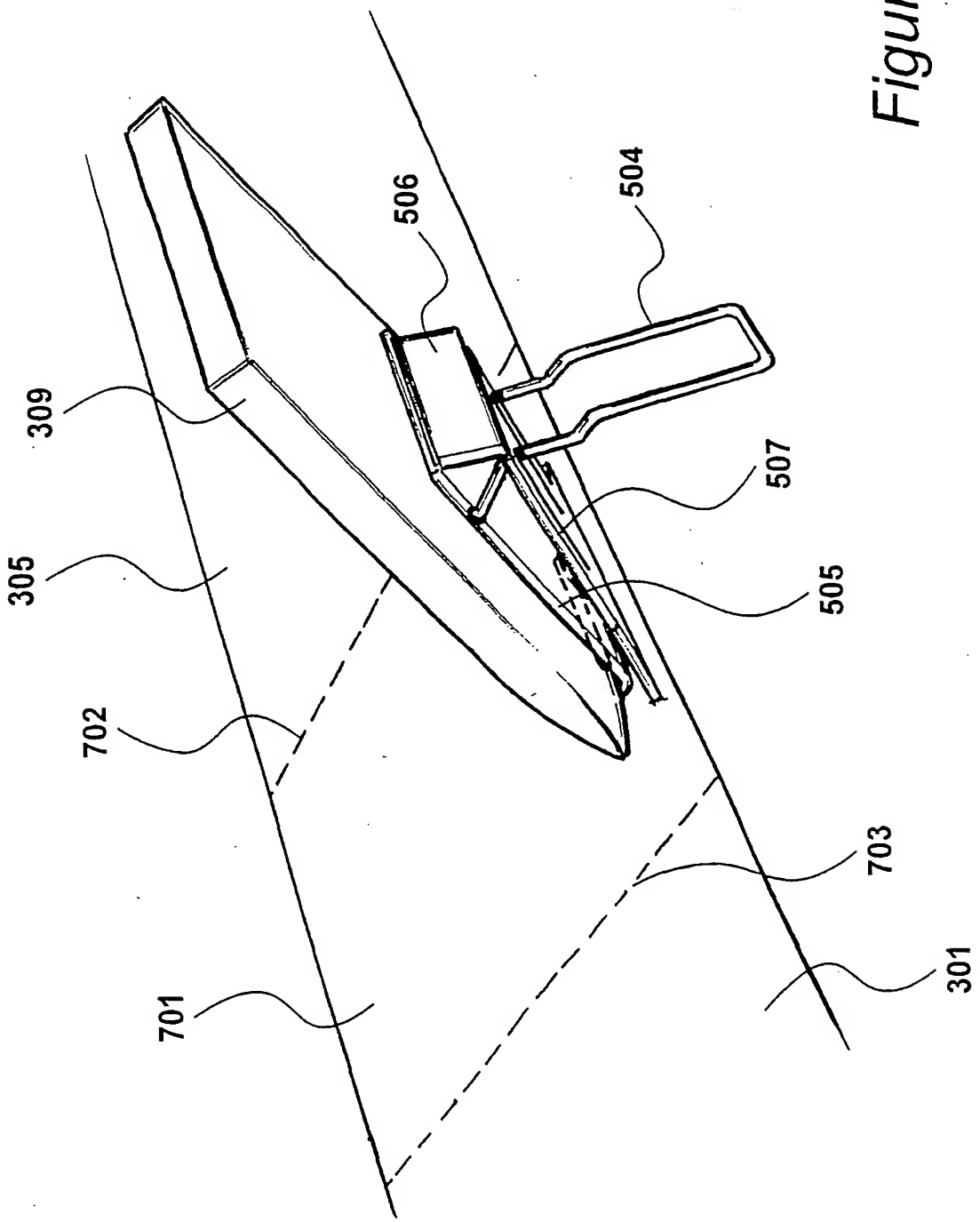

Figure 7

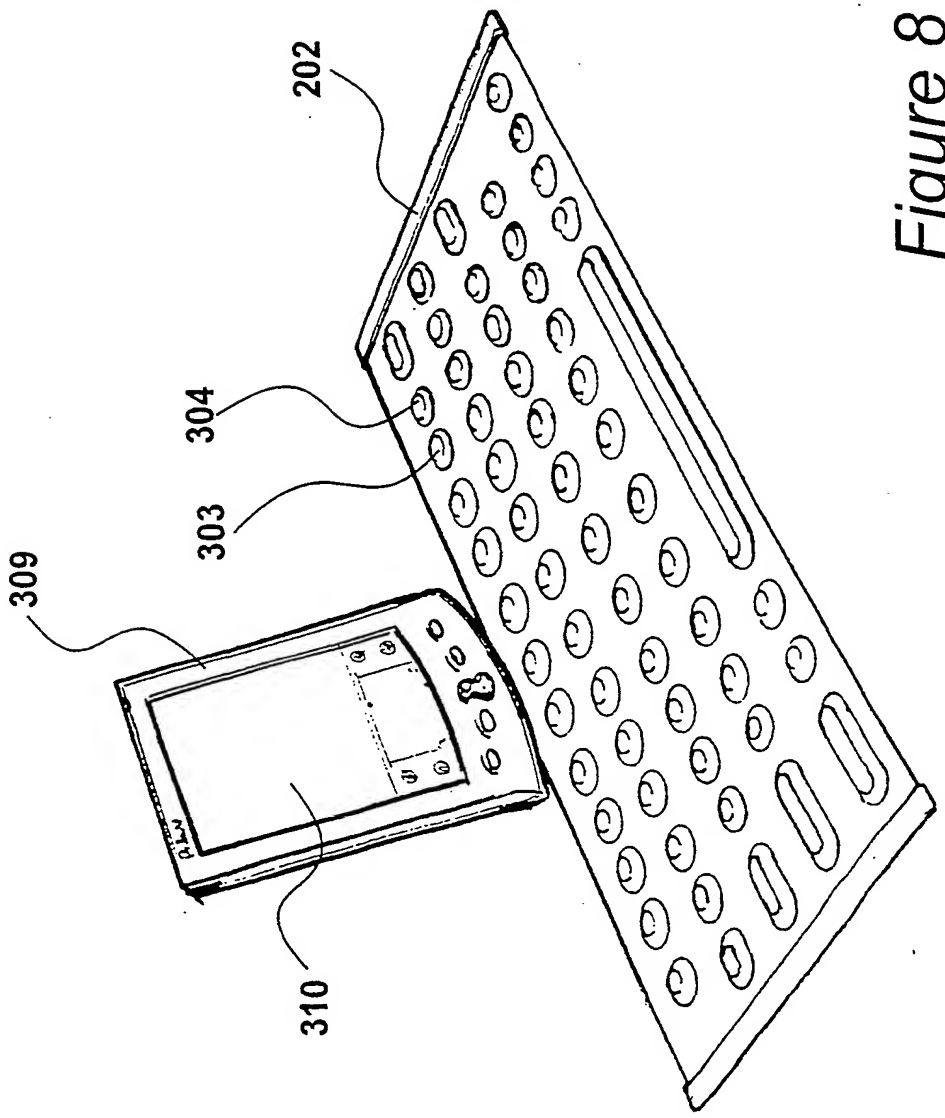

Figure 8

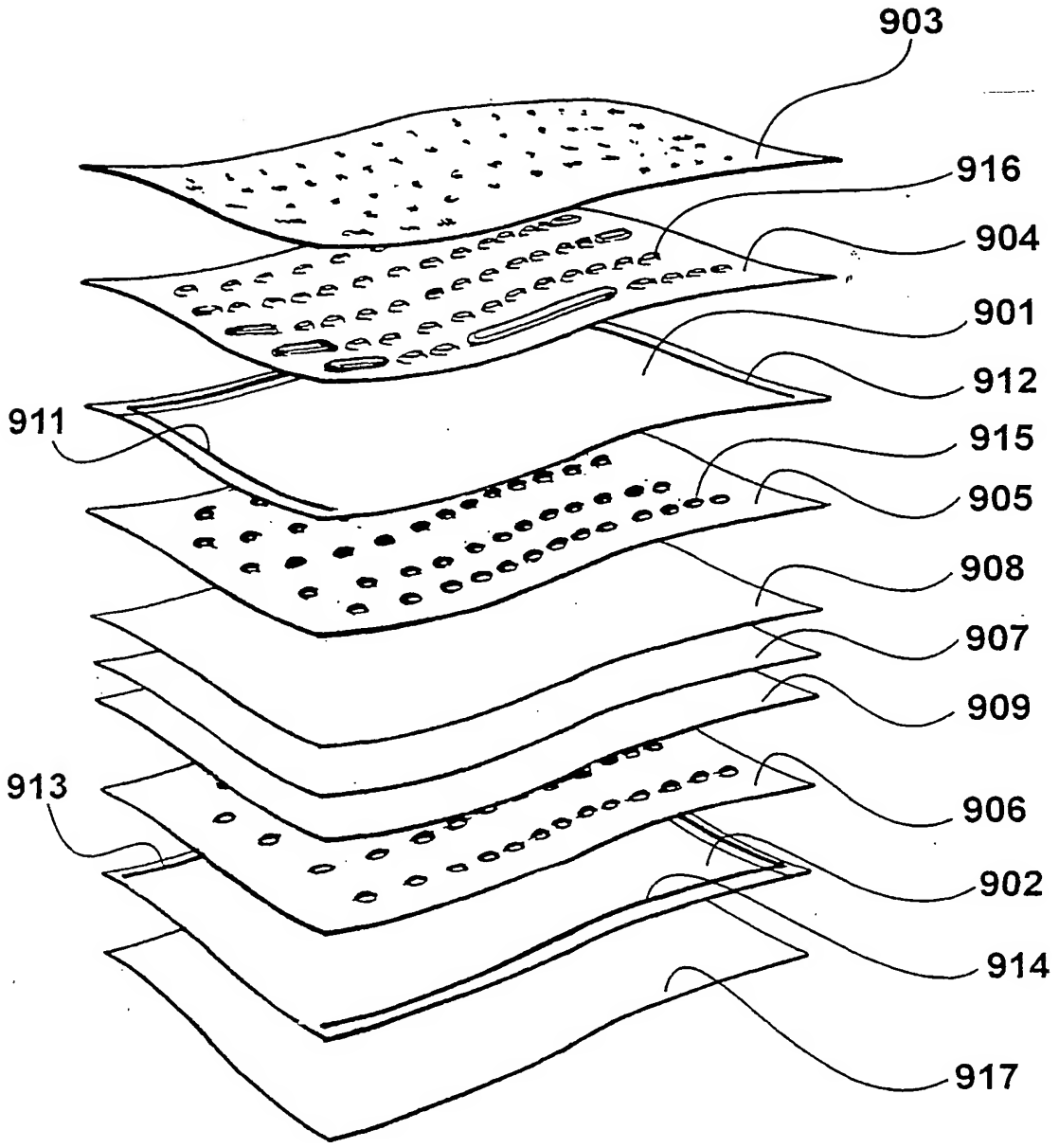

Figure 9

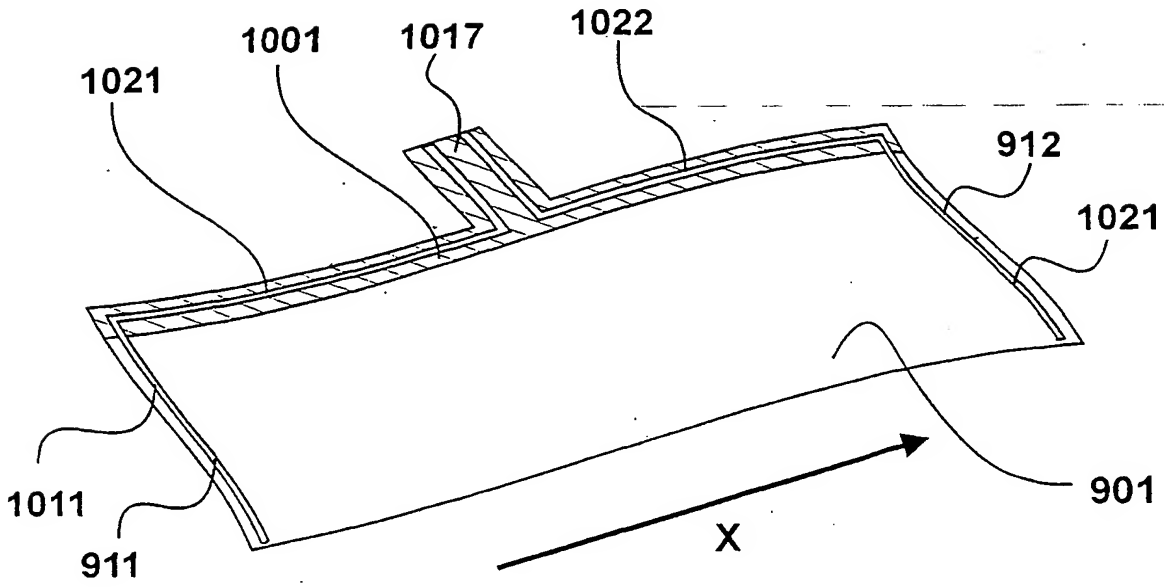

Figure 10A

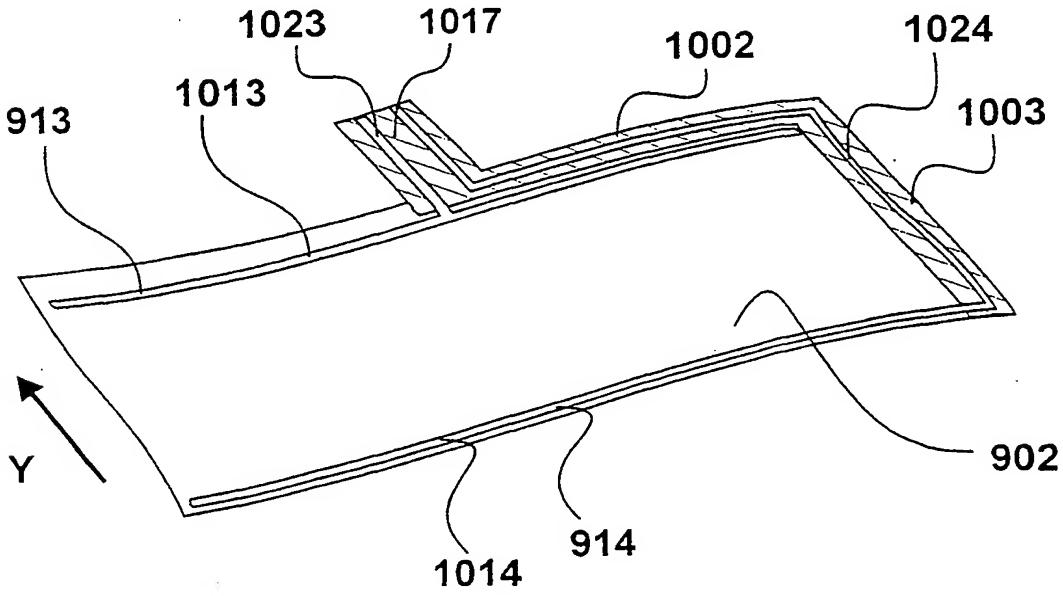

Figure 10B

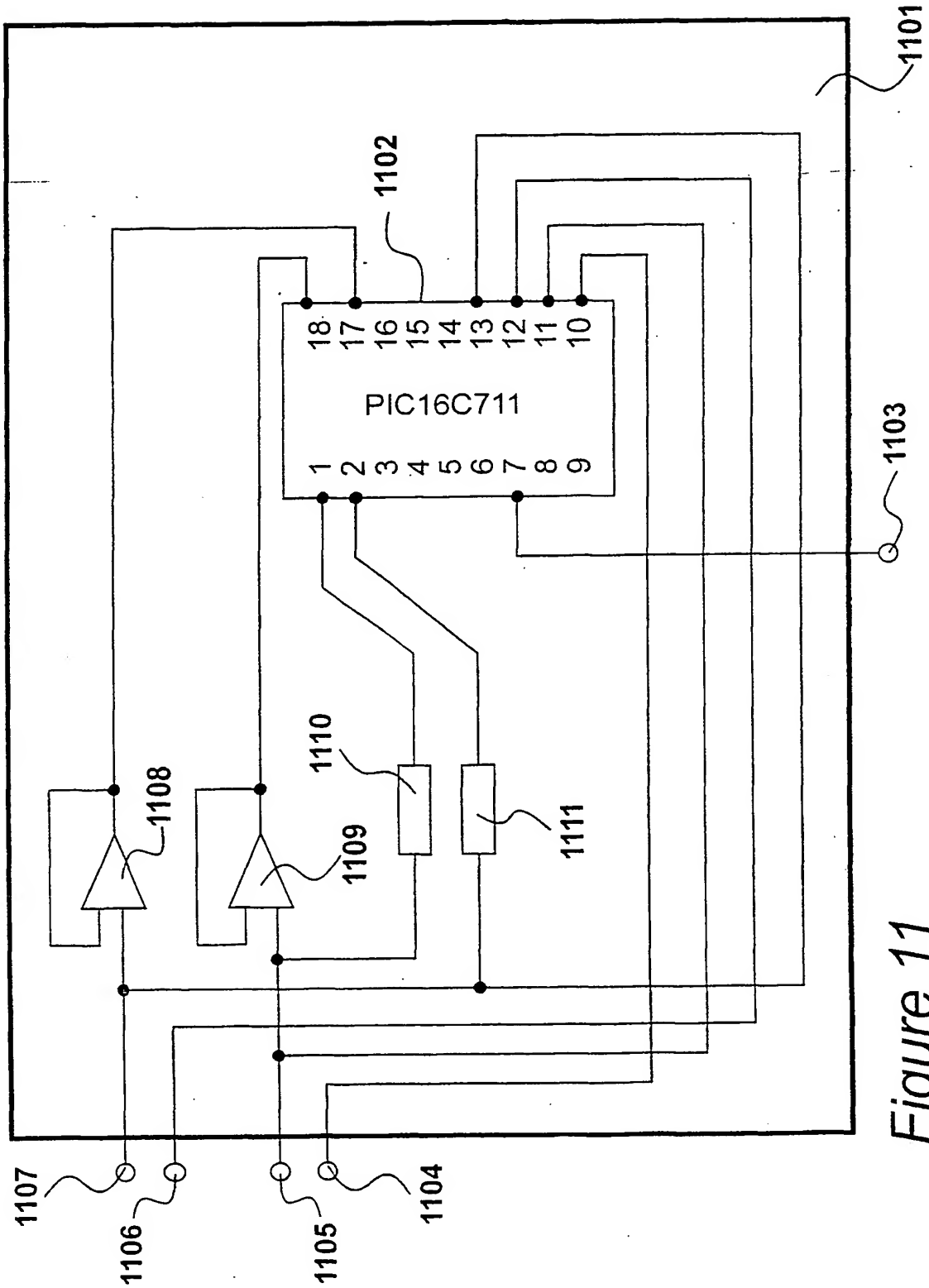
1101
1102
18 17 16 15 14 13 12 11 10
PIC16C711
1 2 3 4 5 6 7 8 9
1103
1110
1108
1109
1111
1107
1106
1105
1104

Figure 11

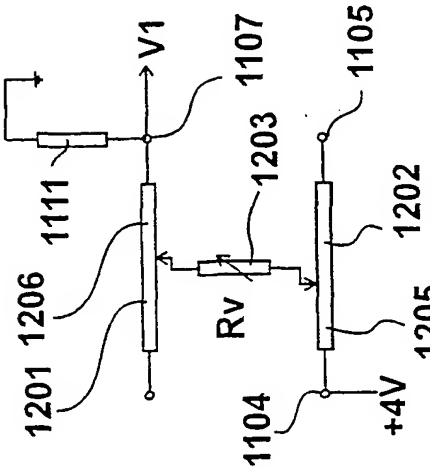

Figure 12A

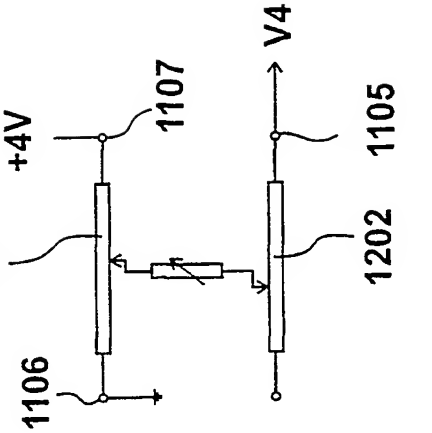

Figure 12D

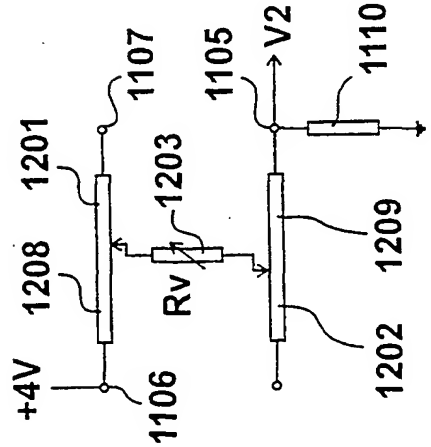

Figure 12B

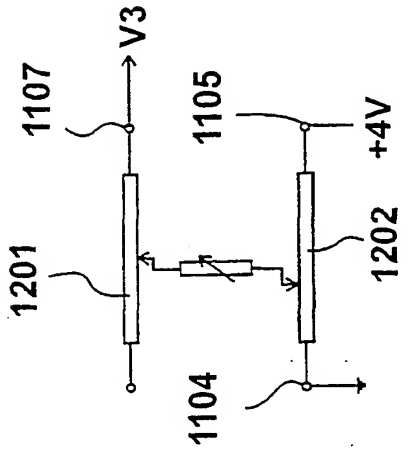

Figure 12C

$$Rv \propto \frac{1}{V_1} + \frac{1}{V_2}$$

1210

$$\frac{1}{Rv} \sim \propto \text{AREA.FORCE}$$

1211

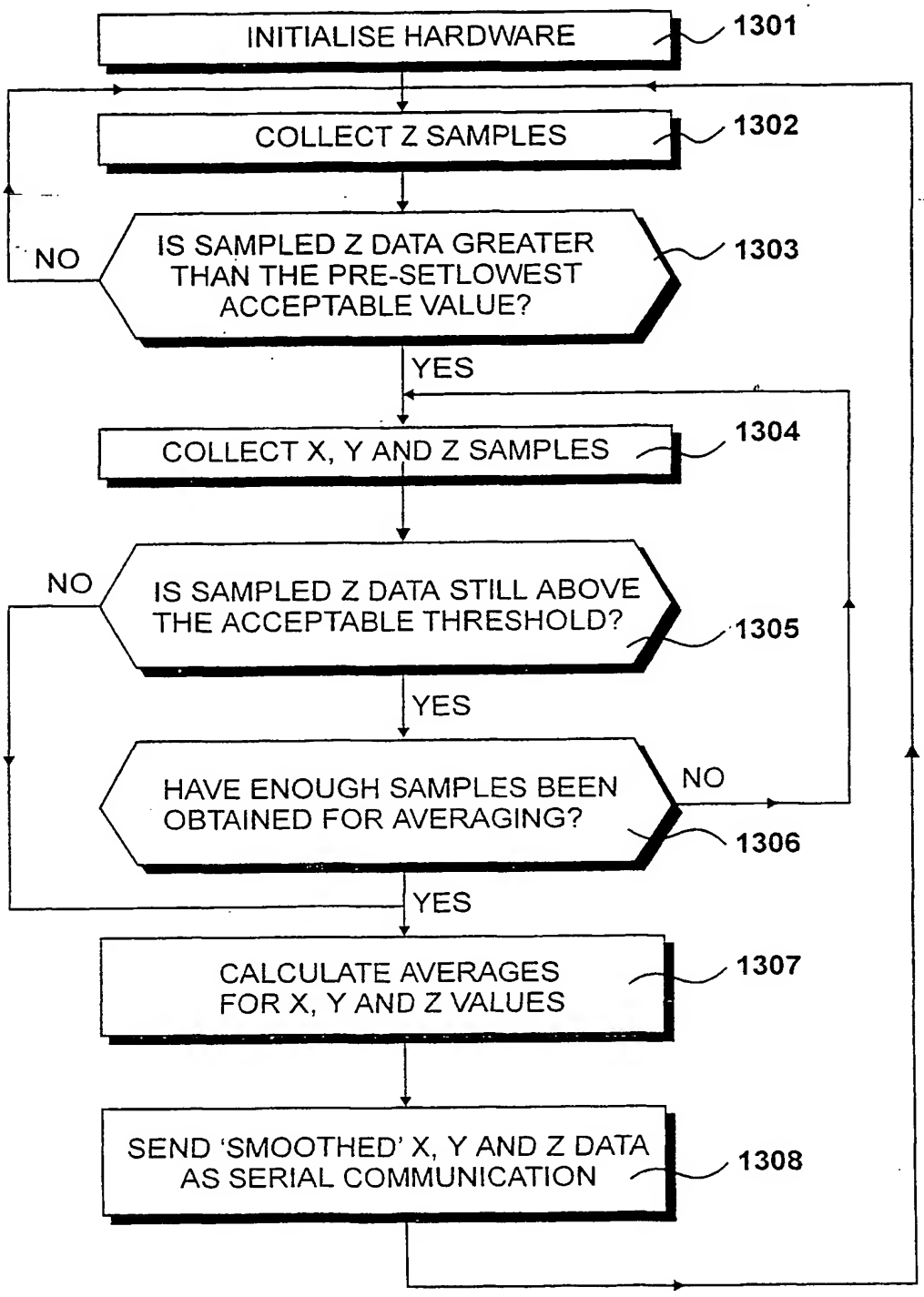
INITIALISE HARDWARE
1301
COLLECT Z SAMPLES
1302
NO
IS SAMPLED Z DATA GREATER THAN THE PRE-SETLOWEST ACCEPTABLE VALUE?
1303
YES
COLLECT X, Y AND Z SAMPLES
1304
NO
IS SAMPLED Z DATA STILL ABOVE THE ACCEPTABLE THRESHOLD?
1305
YES
HAVE ENOUGH SAMPLES BEEN OBTAINED FOR AVERAGING?
NO
1306
YES
CALCULATE AVERAGES FOR X, Y AND Z VALUES
1307
SEND 'SMOOTHED' X, Y AND Z DATA AS SERIAL COMMUNICATION
1308

Figure 13

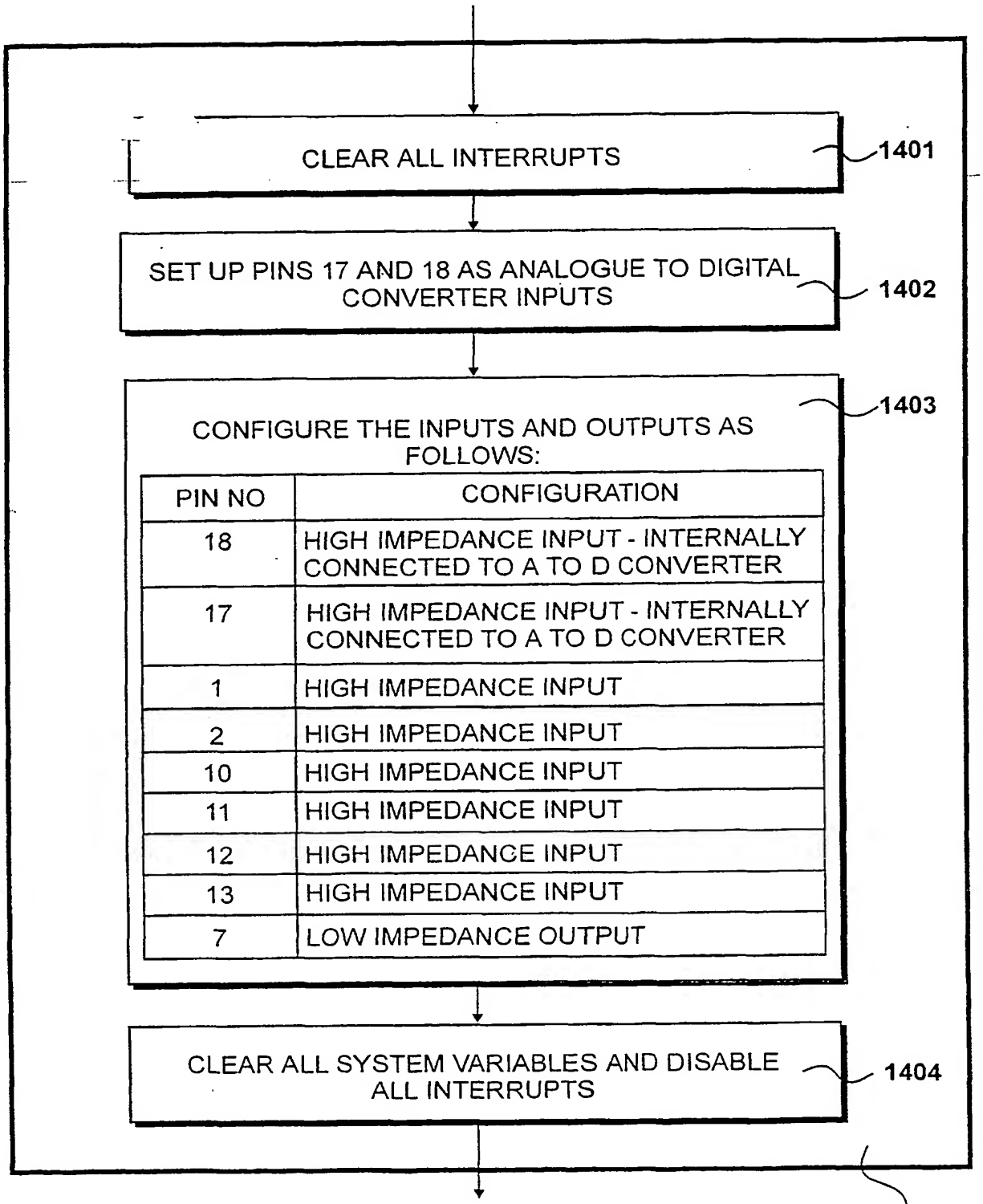
CLEAR ALL INTERRUPTS
1401
SET UP PINS 17 AND 18 AS ANALOGUE TO DIGITAL CONVERTER INPUTS
1402
1403
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN NO
CONFIGURATION
18
HIGH IMPEDANCE INPUT - INTERNALLY CONNECTED TO A TO D CONVERTER
17
HIGH IMPEDANCE INPUT - INTERNALLY CONNECTED TO A TO D CONVERTER
1
HIGH IMPEDANCE INPUT
2
HIGH IMPEDANCE INPUT
10
HIGH IMPEDANCE INPUT
11
HIGH IMPEDANCE INPUT
12
HIGH IMPEDANCE INPUT
13
HIGH IMPEDANCE INPUT
7
LOW IMPEDANCE OUTPUT
CLEAR ALL SYSTEM VARIABLES AND DISABLE ALL INTERRUPTS
1404
1301

Figure 14

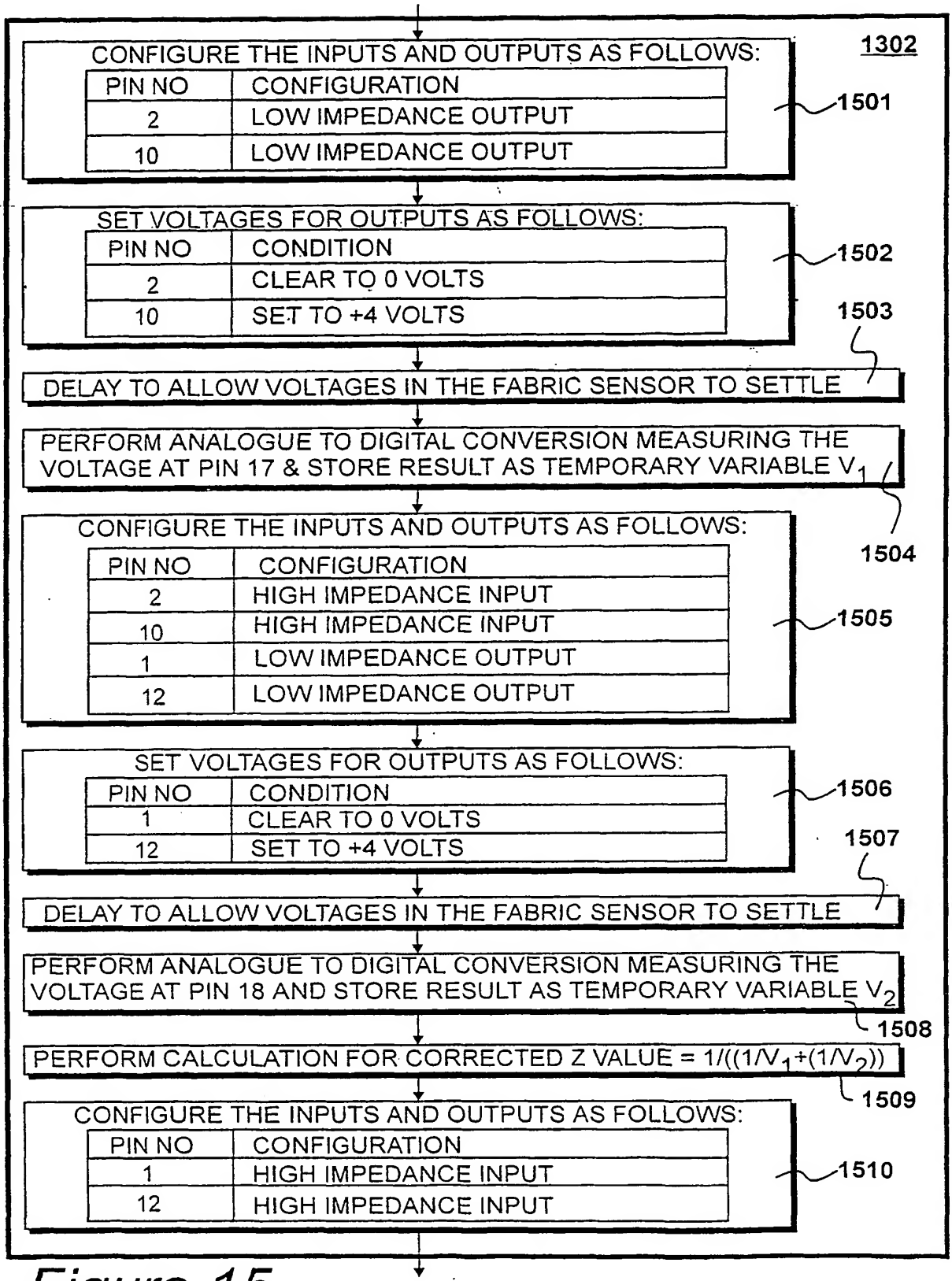
1302
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN NO | CONFIGURATION
2 | LOW IMPEDANCE OUTPUT
10 | LOW IMPEDANCE OUTPUT
1501
SET VOLTAGES FOR OUTPUTS AS FOLLOWS:
PIN NO | CONDITION
2 | CLEAR TO 0 VOLTS
10 | SET TO +4 VOLTS
1502
1503
DELAY TO ALLOW VOLTAGES IN THE FABRIC SENSOR TO SETTLE
PERFORM ANALOGUE TO DIGITAL CONVERSION MEASURING THE VOLTAGE AT PIN 17 & STORE RESULT AS TEMPORARY VARIABLE V1
1504
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN NO | CONFIGURATION
2 | HIGH IMPEDANCE INPUT
10 | HIGH IMPEDANCE INPUT
1 | LOW IMPEDANCE OUTPUT
12 | LOW IMPEDANCE OUTPUT
1505
SET VOLTAGES FOR OUTPUTS AS FOLLOWS:
PIN NO | CONDITION
1 | CLEAR TO 0 VOLTS
12 | SET TO +4 VOLTS
1506
1507
DELAY TO ALLOW VOLTAGES IN THE FABRIC SENSOR TO SETTLE
PERFORM ANALOGUE TO DIGITAL CONVERSION MEASURING THE VOLTAGE AT PIN 18 AND STORE RESULT AS TEMPORARY VARIABLE V2
1508
PERFORM CALCULATION FOR CORRECTED Z VALUE = 1/((1/V1+(1/V2))
1509
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN NO | CONFIGURATION
1 | HIGH IMPEDANCE INPUT
12 | HIGH IMPEDANCE INPUT
1510

Figure 15

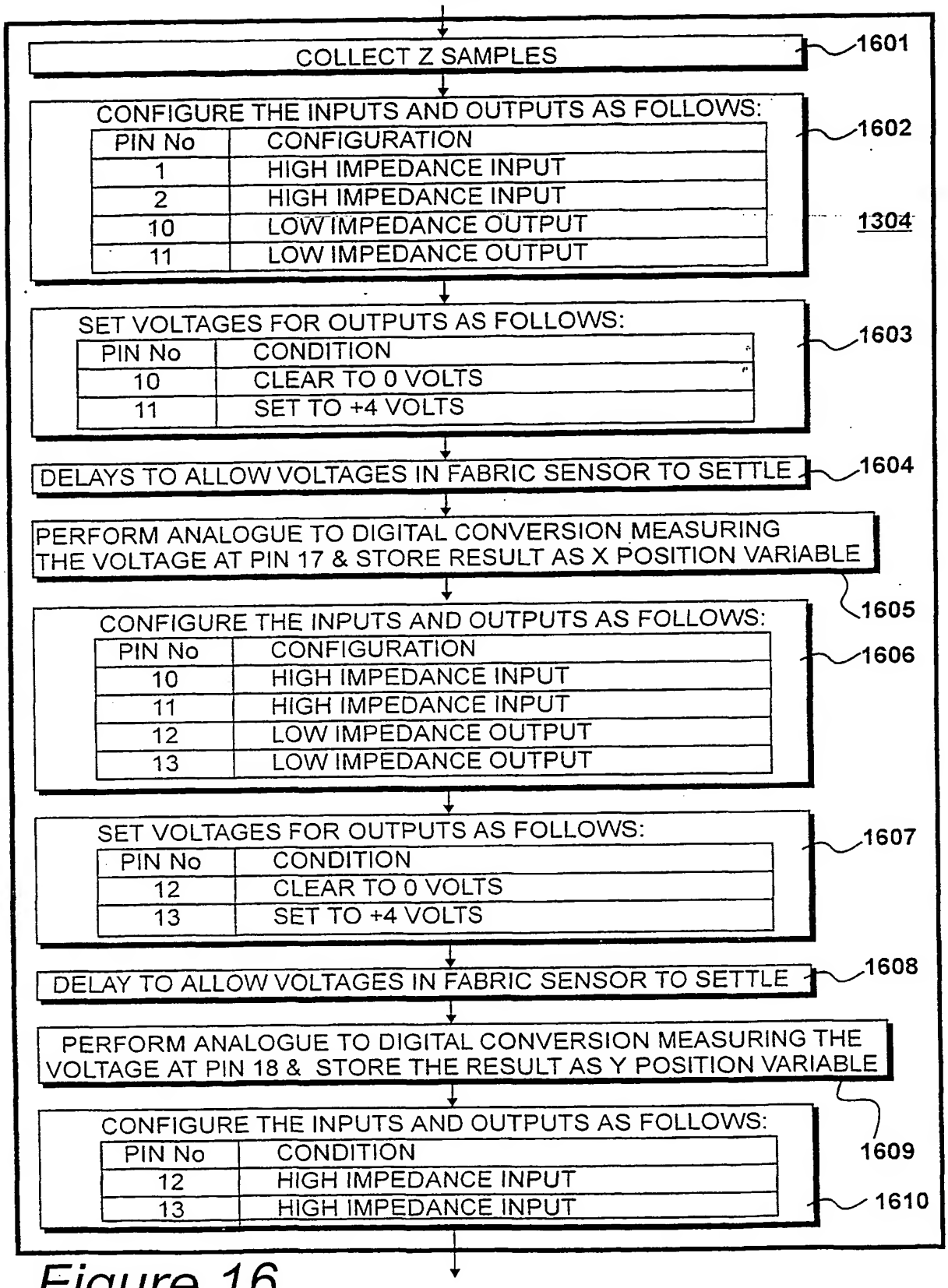
COLLECT Z SAMPLES
1601
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN No | CONFIGURATION
1 | HIGH IMPEDANCE INPUT
2 | HIGH IMPEDANCE INPUT
10 | LOW IMPEDANCE OUTPUT
11 | LOW IMPEDANCE OUTPUT
1602
1304
SET VOLTAGES FOR OUTPUTS AS FOLLOWS:
PIN No | CONDITION
10 | CLEAR TO 0 VOLTS
11 | SET TO +4 VOLTS
1603
DELAYS TO ALLOW VOLTAGES IN FABRIC SENSOR TO SETTLE
1604
PERFORM ANALOGUE TO DIGITAL CONVERSION MEASURING THE VOLTAGE AT PIN 17 & STORE RESULT AS X POSITION VARIABLE
1605
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN No | CONFIGURATION
10 | HIGH IMPEDANCE INPUT
11 | HIGH IMPEDANCE INPUT
12 | LOW IMPEDANCE OUTPUT
13 | LOW IMPEDANCE OUTPUT
1606
SET VOLTAGES FOR OUTPUTS AS FOLLOWS:
PIN No | CONDITION
12 | CLEAR TO 0 VOLTS
13 | SET TO +4 VOLTS
1607
DELAY TO ALLOW VOLTAGES IN FABRIC SENSOR TO SETTLE
1608
PERFORM ANALOGUE TO DIGITAL CONVERSION MEASURING THE VOLTAGE AT PIN 18 & STORE THE RESULT AS Y POSITION VARIABLE
1609
CONFIGURE THE INPUTS AND OUTPUTS AS FOLLOWS:
PIN No | CONDITION
12 | HIGH IMPEDANCE INPUT
13 | HIGH IMPEDANCE INPUT
1610

Figure 16

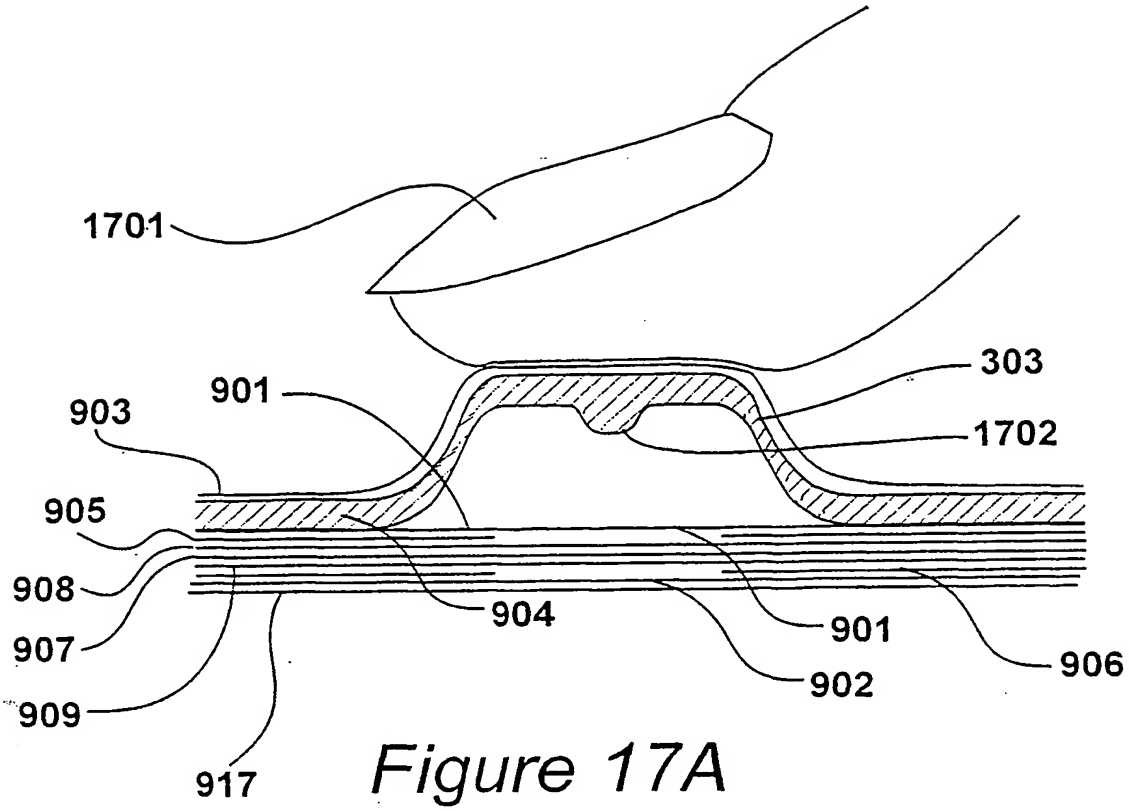

Figure 17A

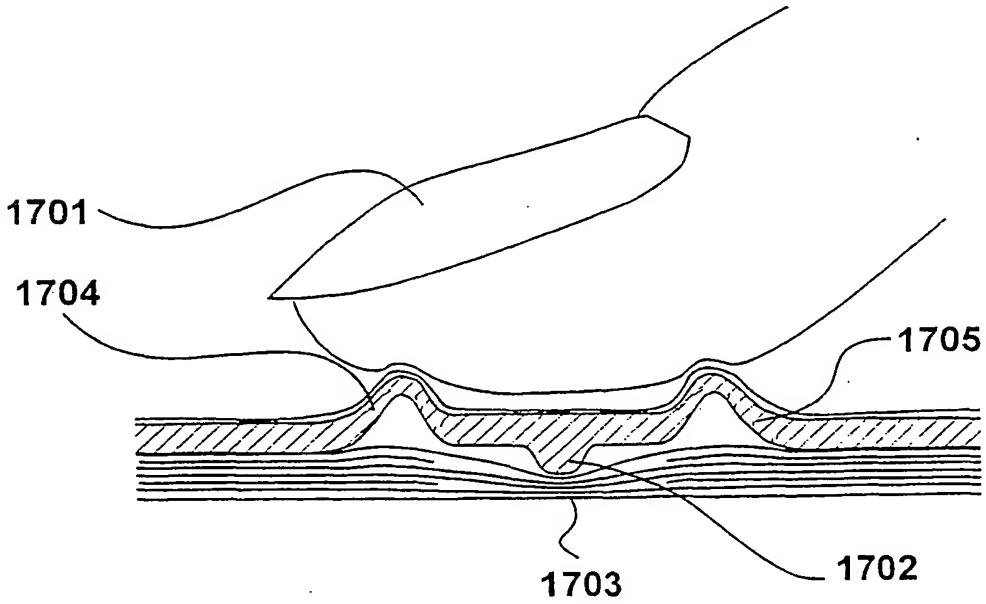

Figure 17B

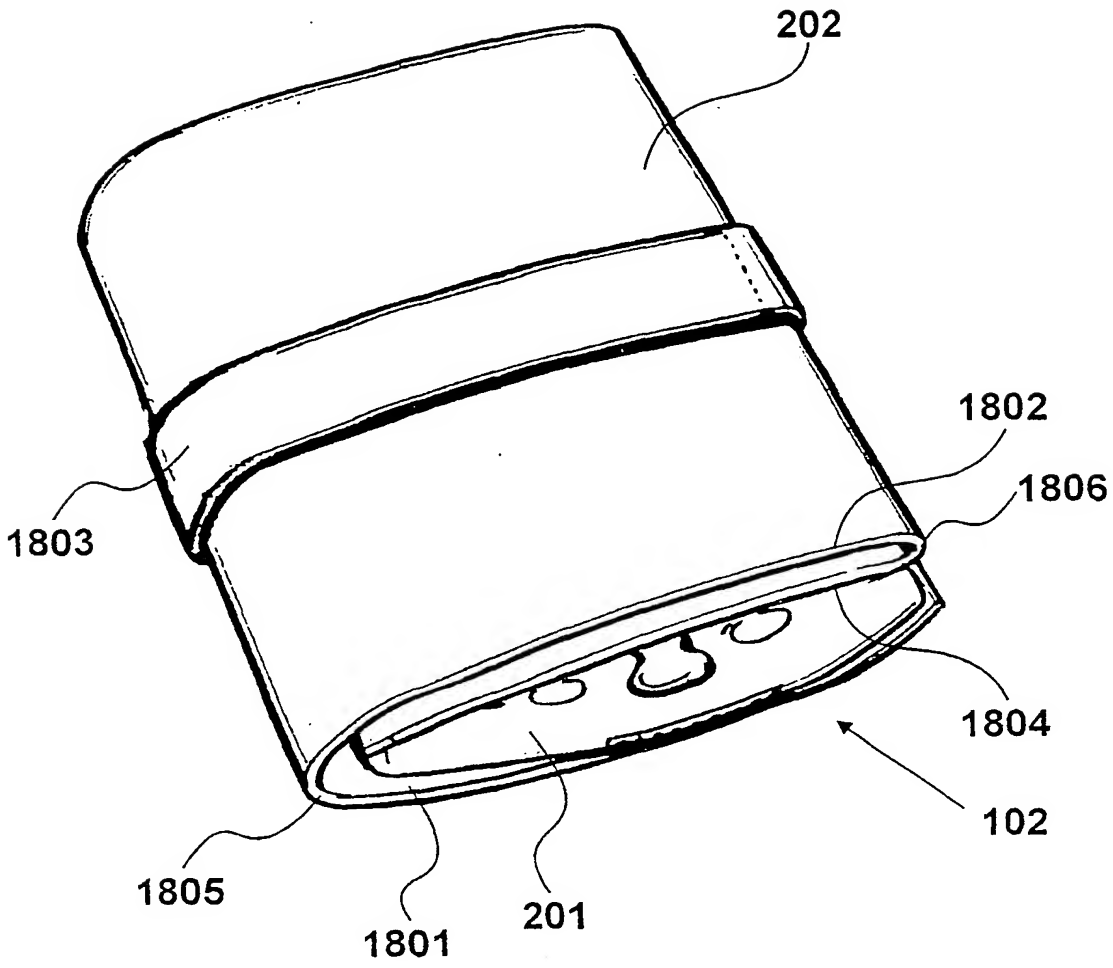

Figure 18

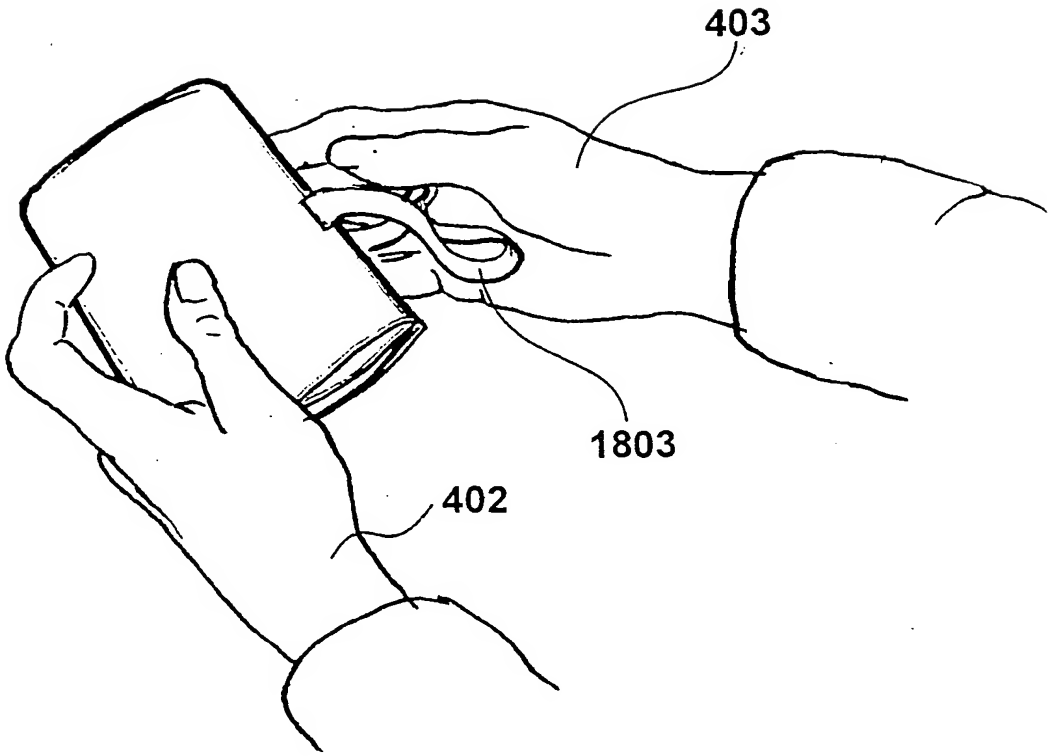

Figure 19

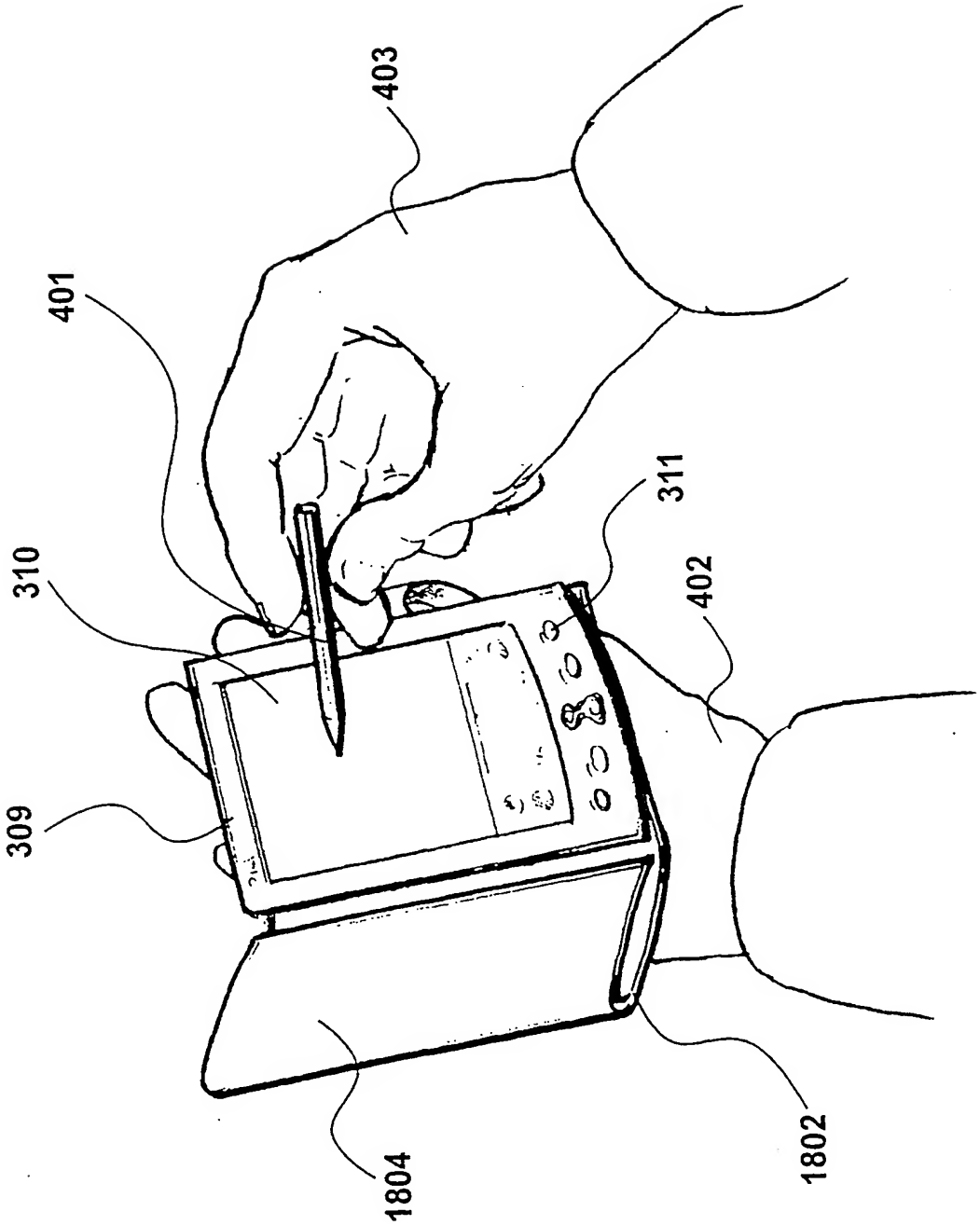

Figure 20

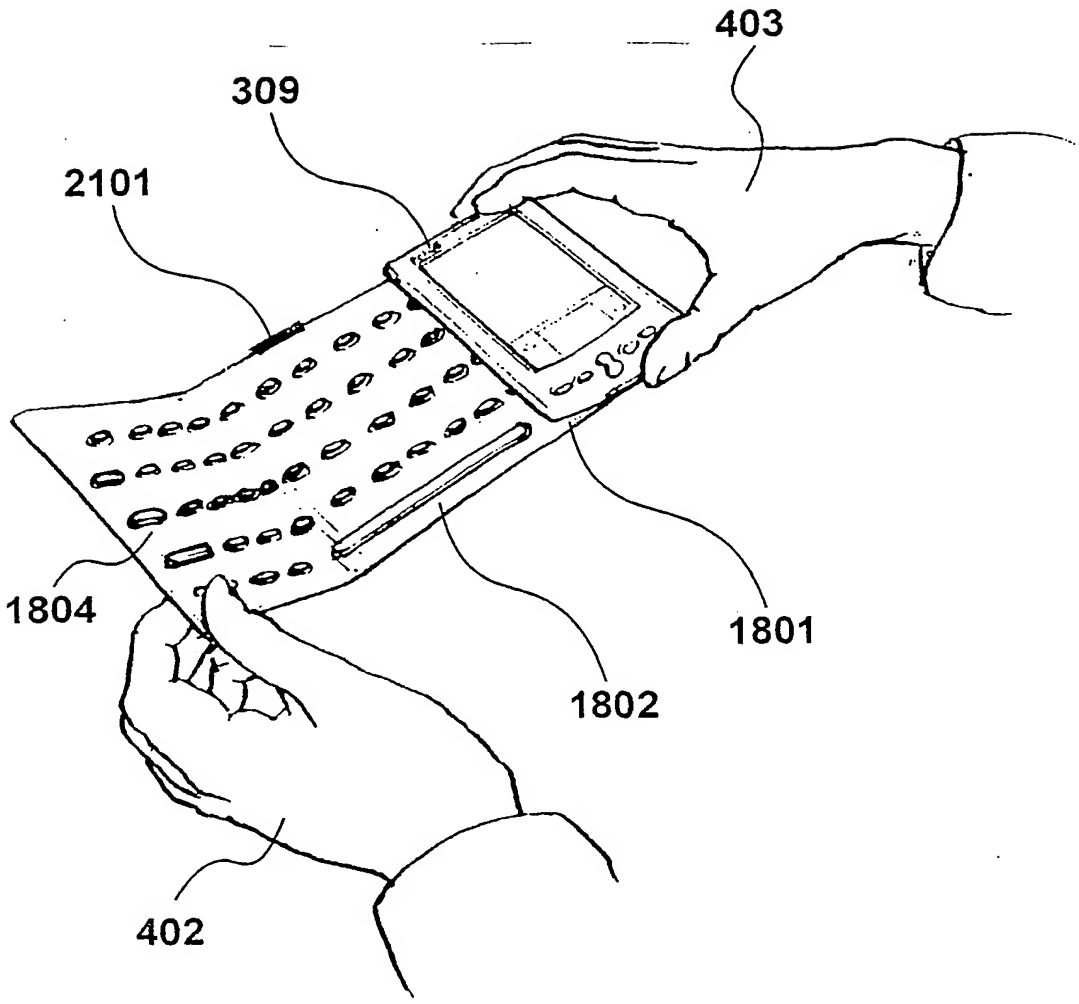

Figure 21

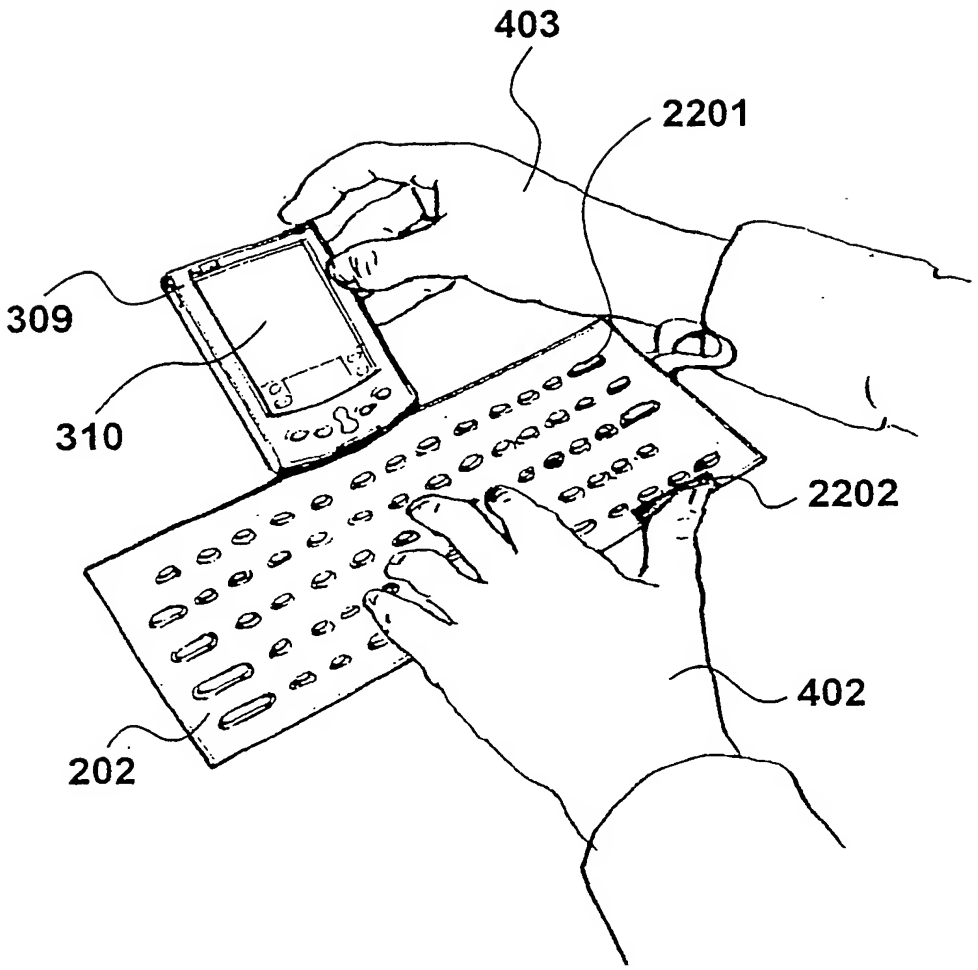

Figure 22

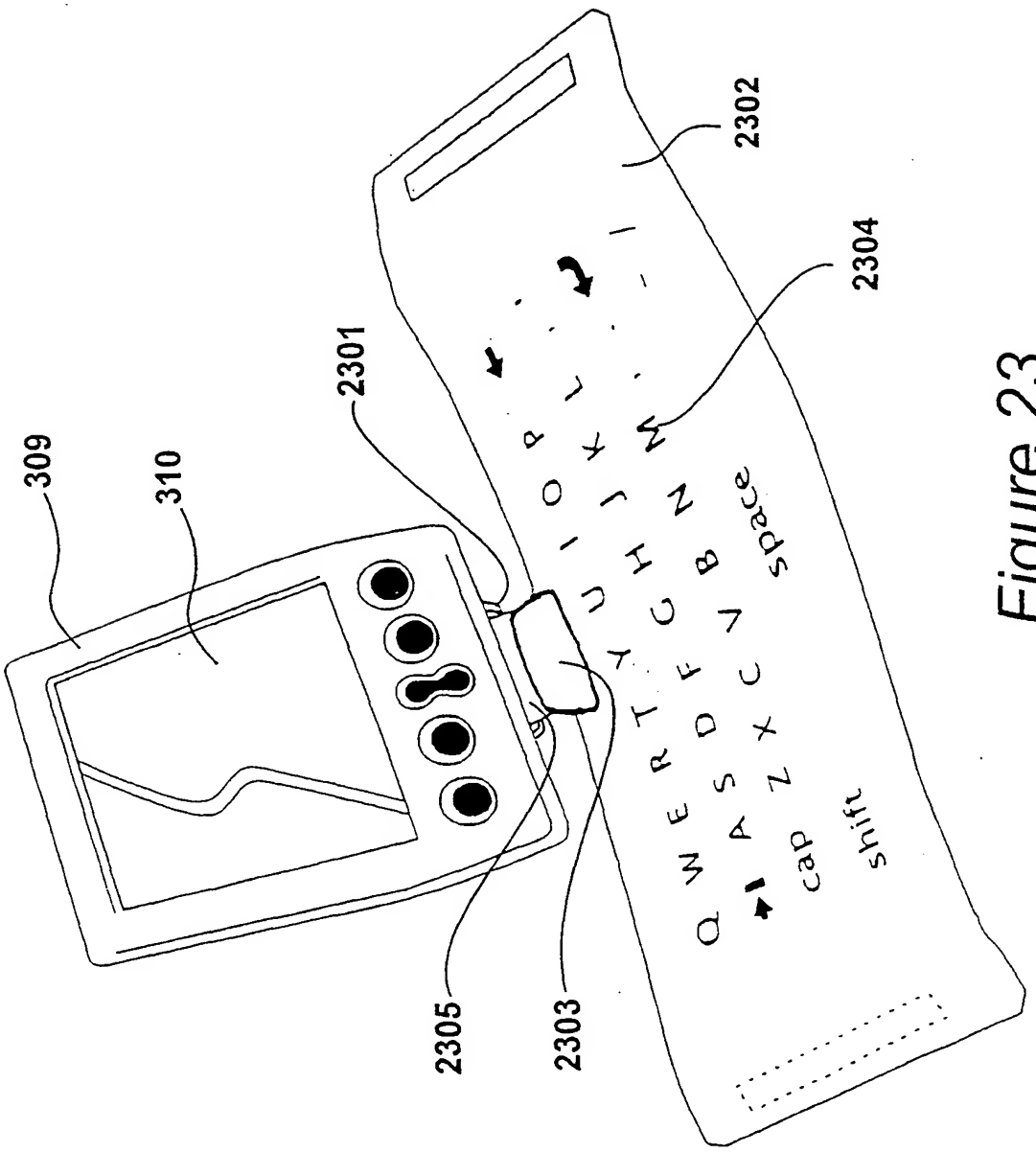

Figure 23

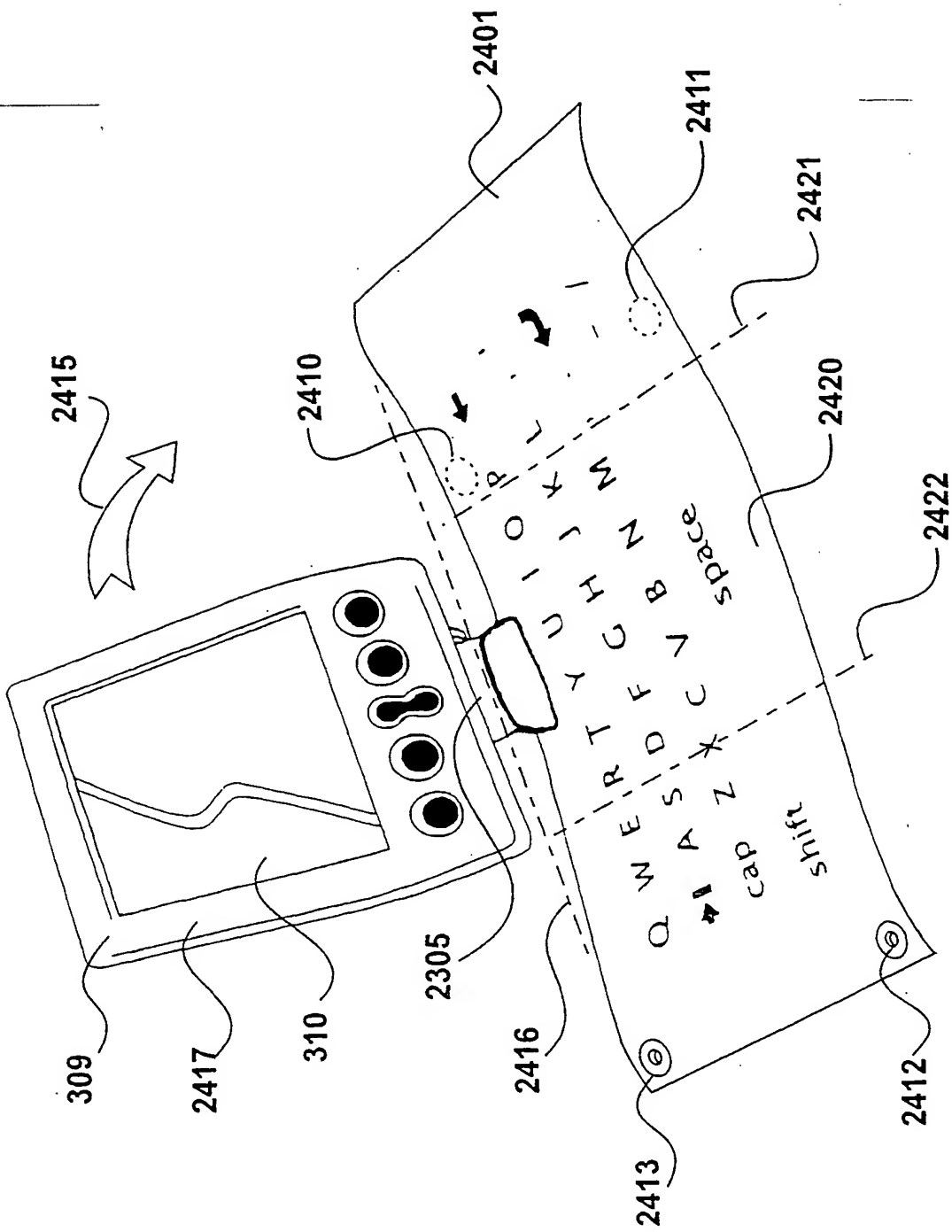
2401
2411
2421
2415
2410
2420
2422
space
cap
shift
309
2417
310
2305
2416
2413
2412

Figure 24

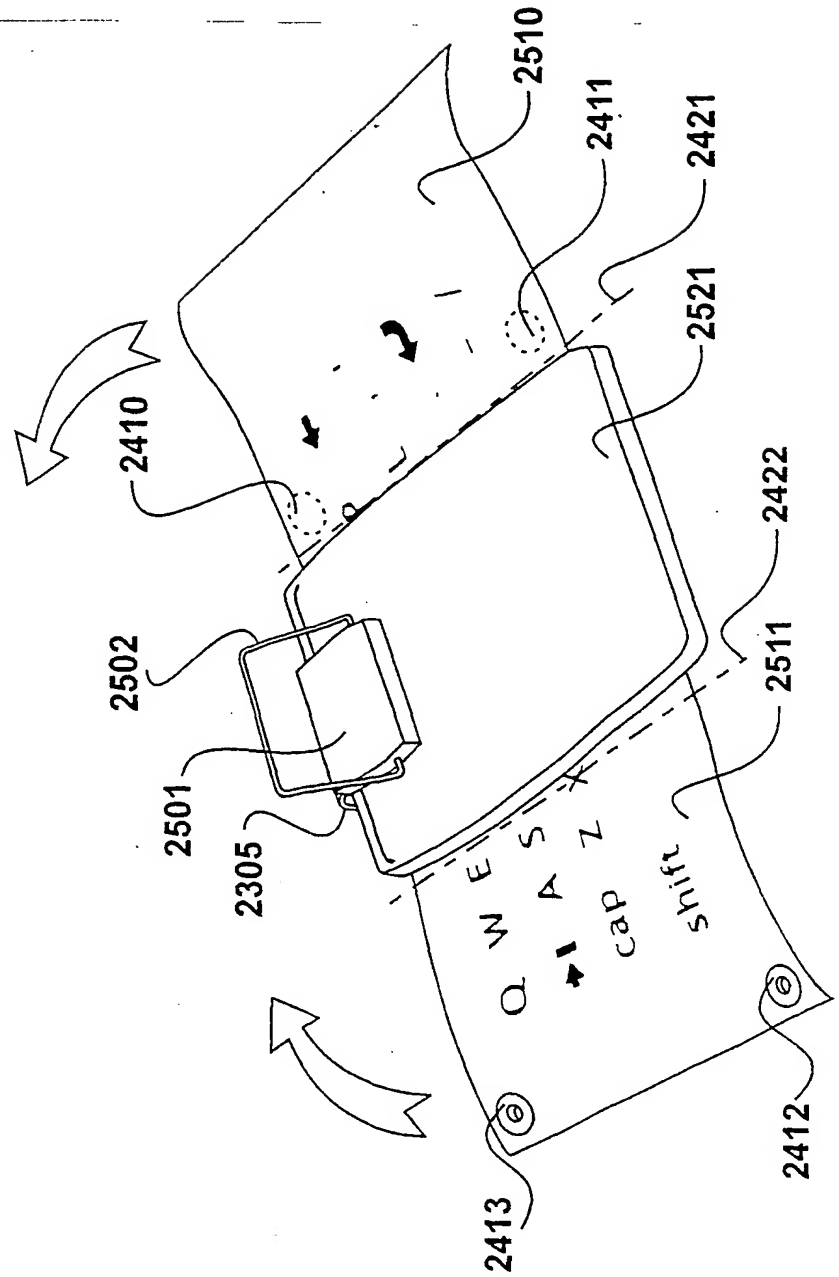
2510
2411
2421
2521
2410
2422
2502
2511
2501
2305
2412
2413
cap
shift

Figure 25

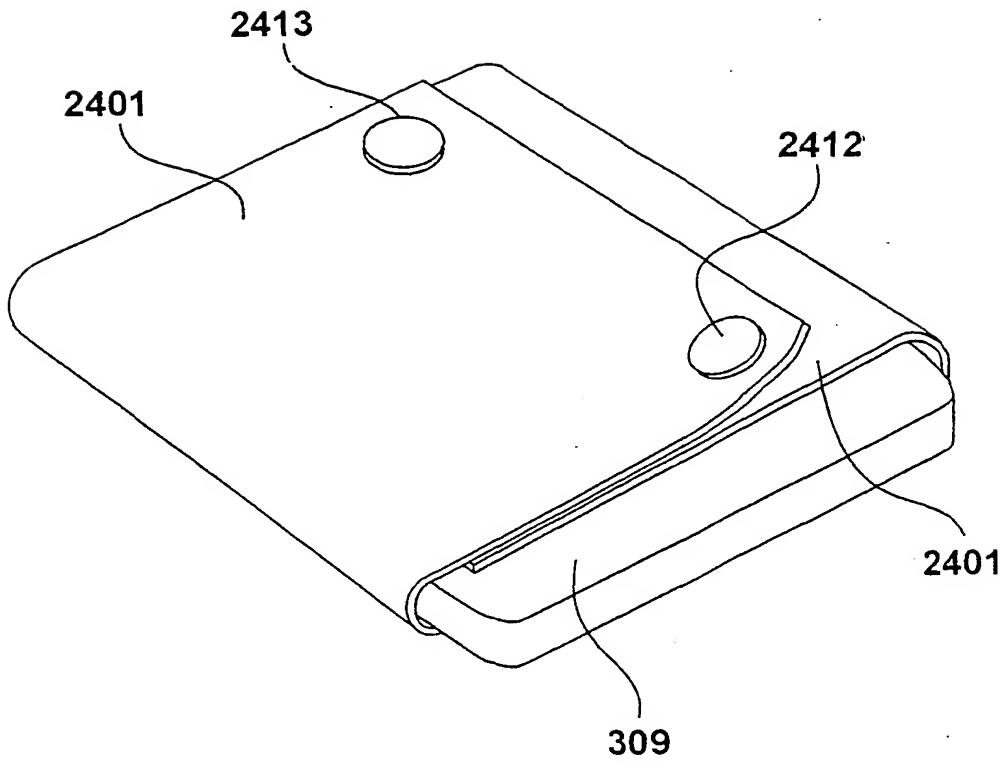

Figure 26

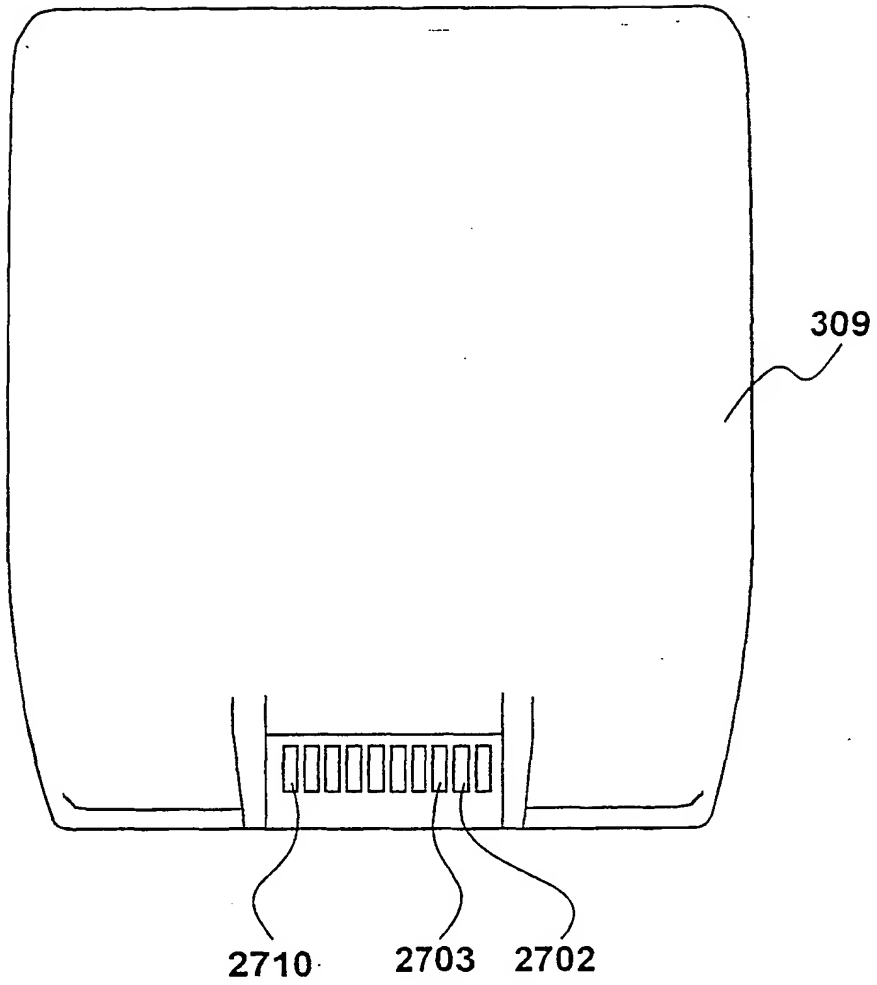

Figure 27

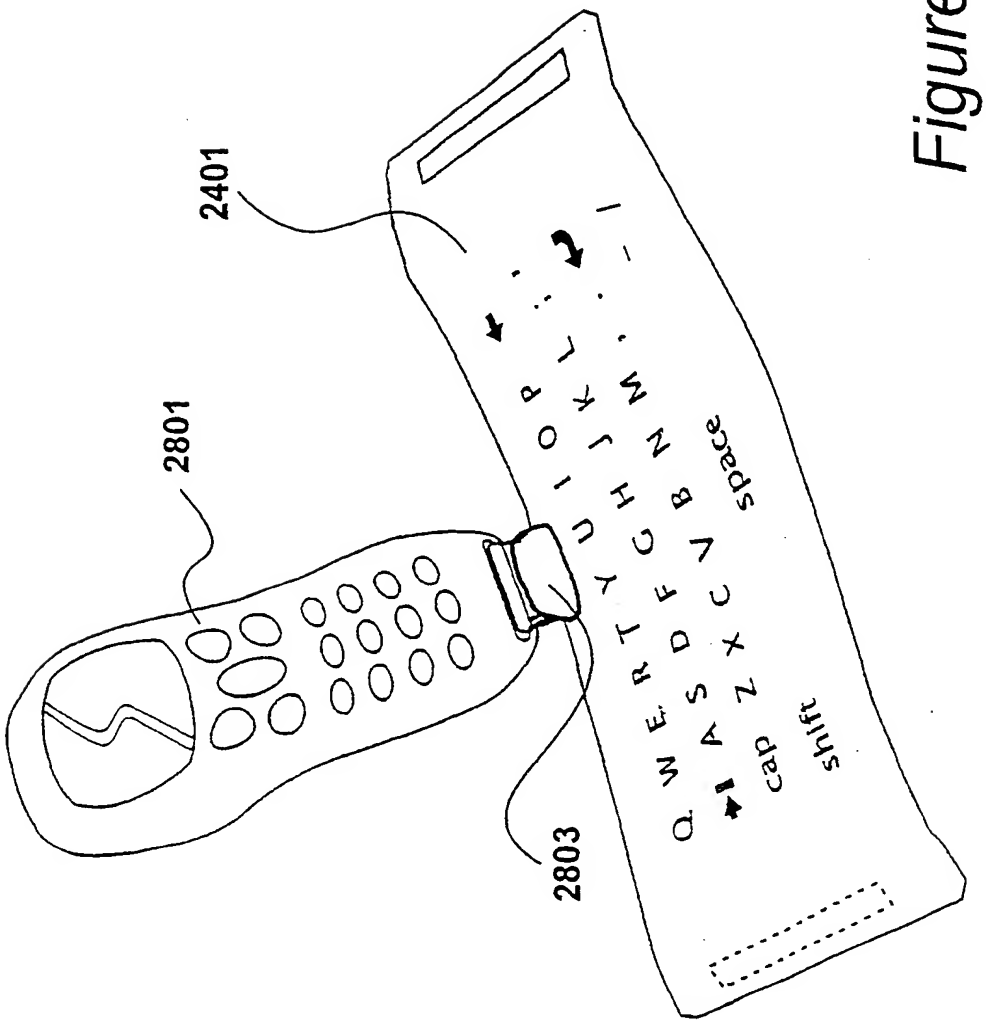
2401
2801
2803
Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M
space
cap
shift

Figure 28

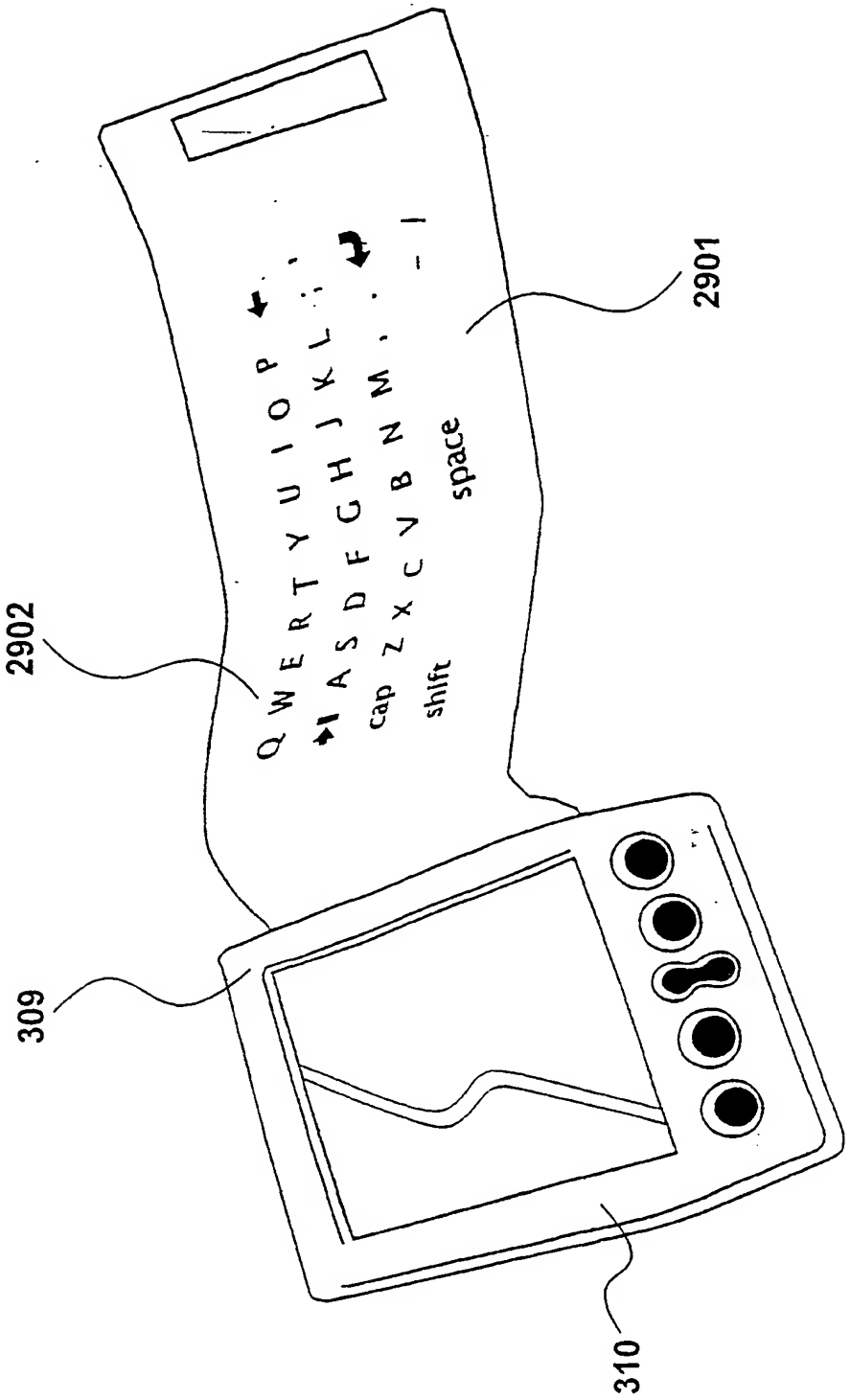
2901
2902
309
310
Q W E R T Y U I O P
A S D F G H J K L
cap Z X C V B N M
shift
space

Figure 29

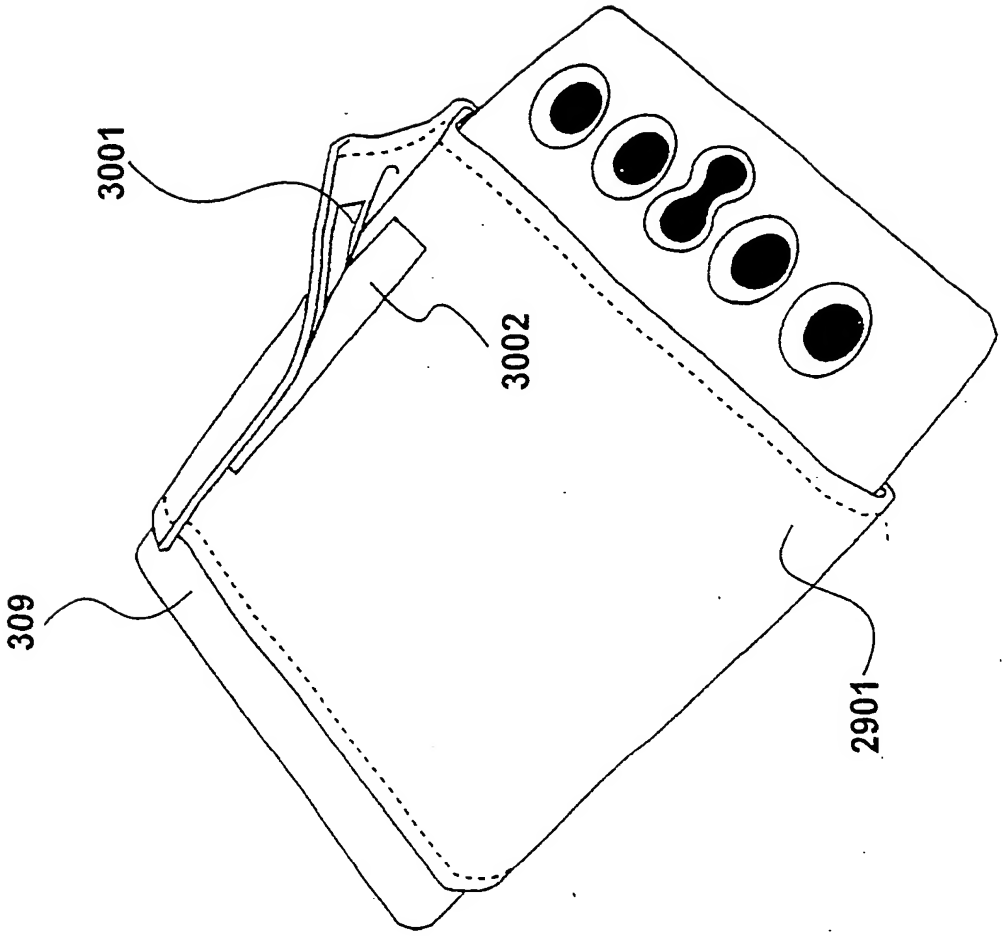

Figure 30

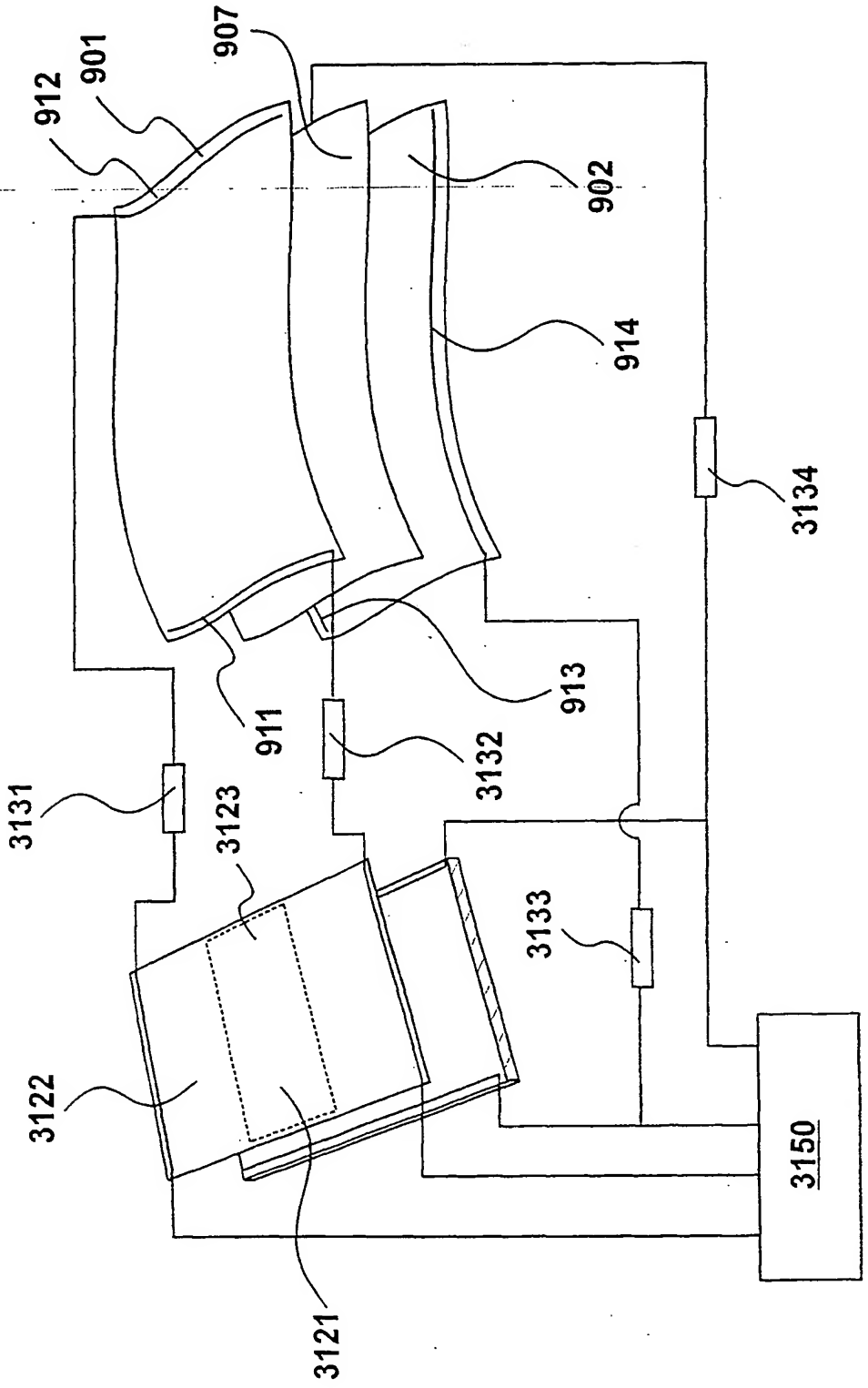
907
901
912
902
914
3134
913
911
3132
3131
3123
3133
3122
3150
3121

Figure 31

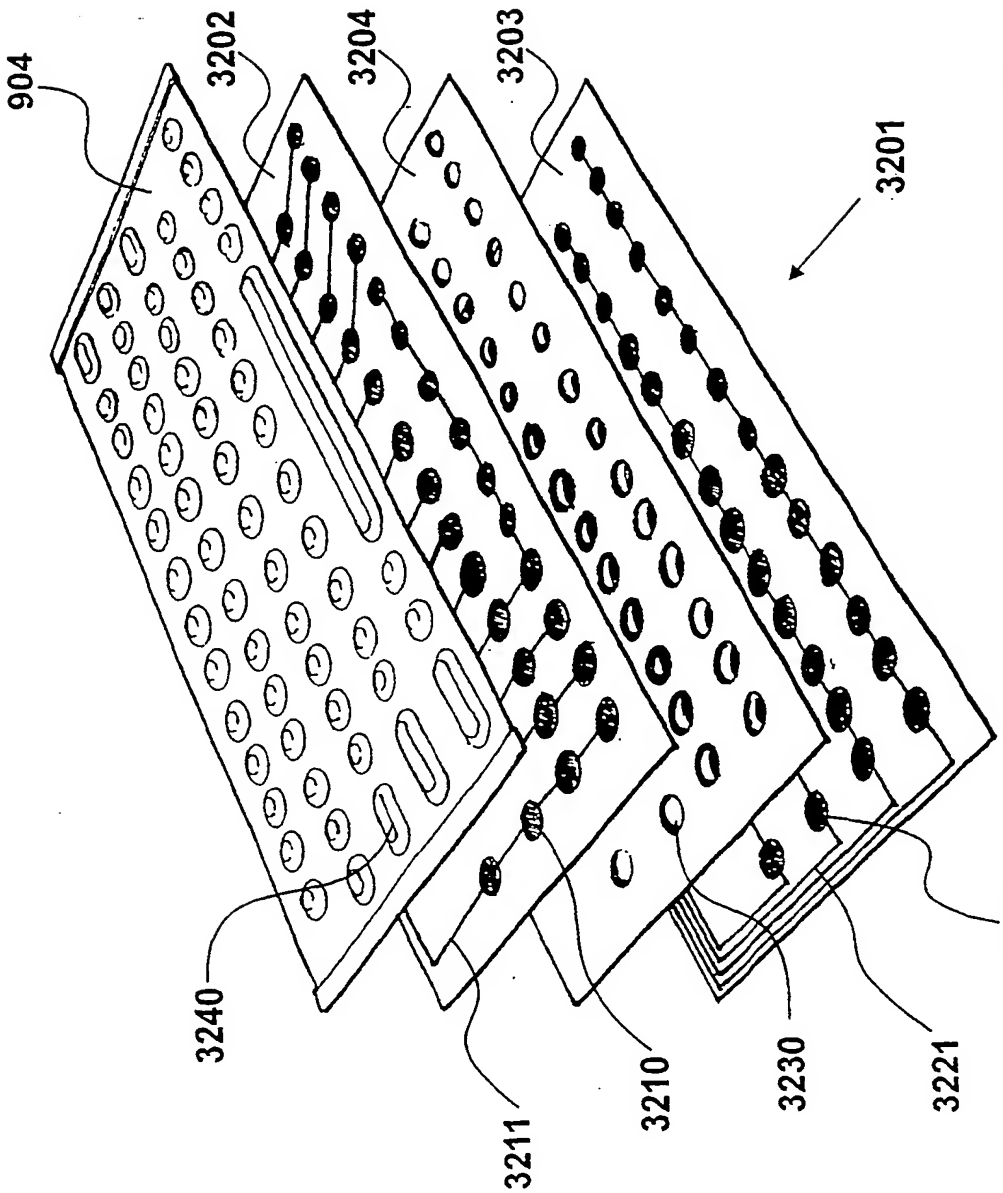

Figure 32

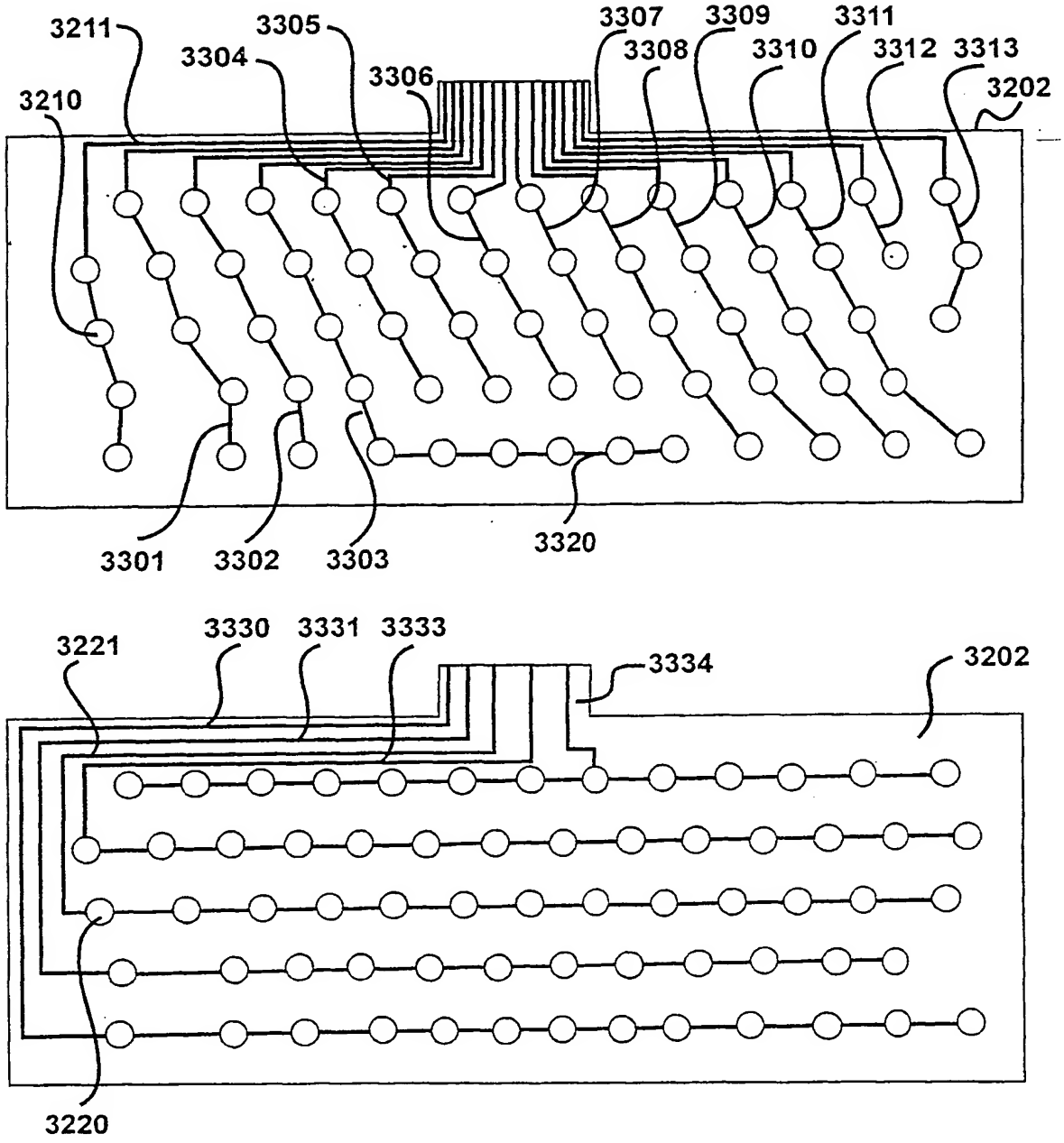
3211
3305
3307
3309
3311
3304
3308
3310
3312
3313
3306
3210
3202
3301
3302
3303
3320
3221
3330
3331
3333
3334
3202
3220

Figure 33

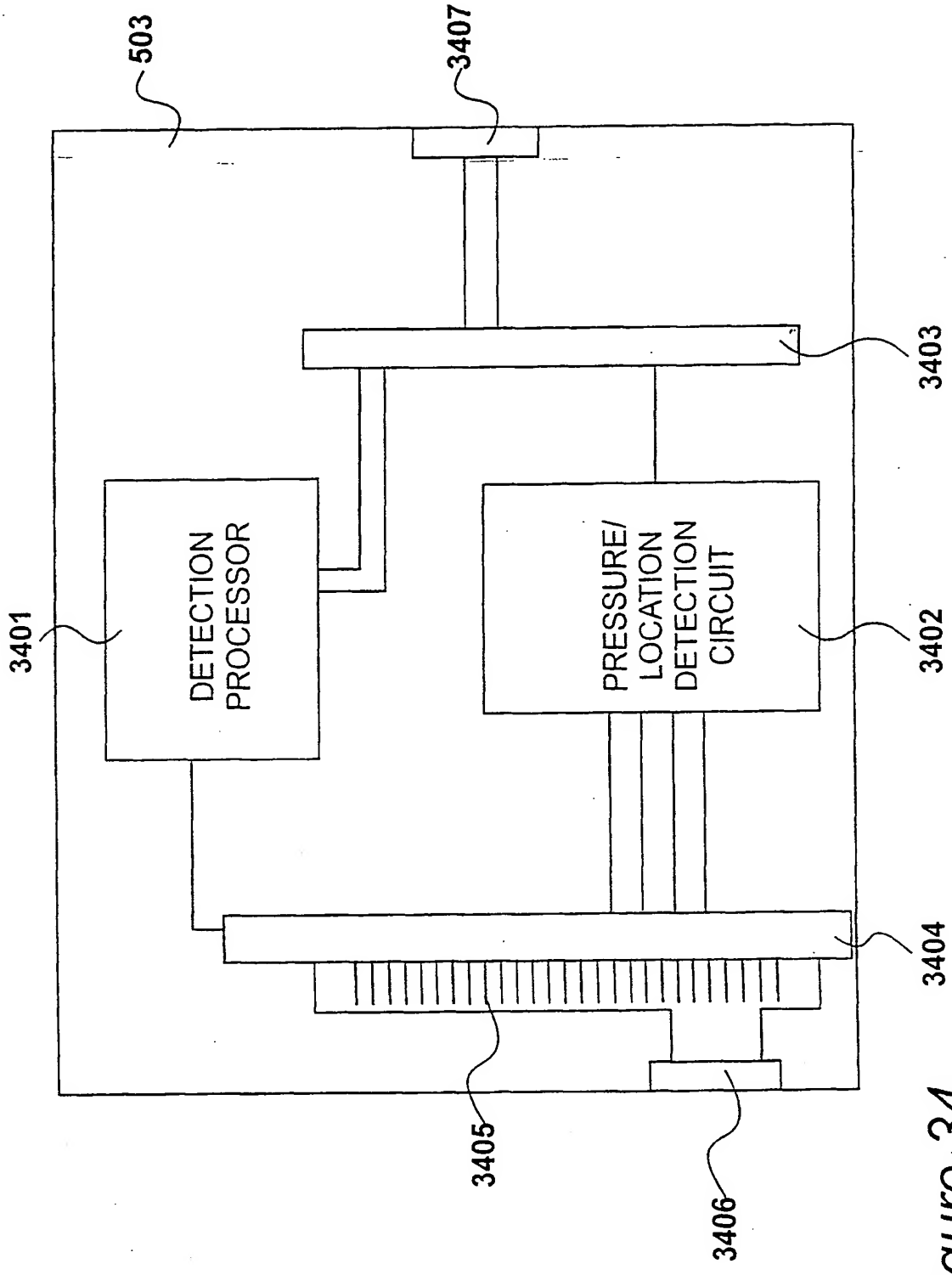
503
3407
3403
DETECTION PROCESSOR
3401
PRESSURE/ LOCATION DETECTION CIRCUIT
3402
3404
3405
3406

Figure 34

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(71) Applicant *(for all designated States except US)*: ELECTROTEXTILES COMPANY LIMITED [GB/GB]; Charter Court, Midland Road, Hemel Hempstead, Hertfordshire HP2 5GE (GB).

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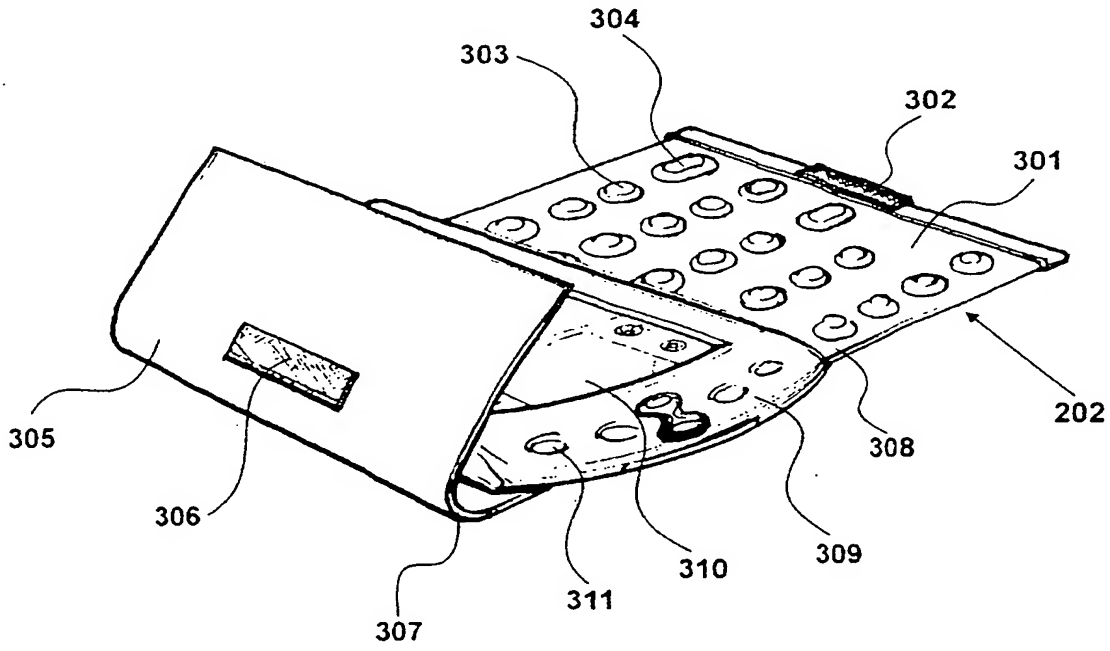
(74) Agent: ATKINSON, Ralph; Atkinson Burrington, 25-29 President Buildings, President Way, Sheffield S4 7UR (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European

[Continued on next page]

(54) Title: MANUAL INPUT APPARATUS AND PROCESSOR



(57) Abstract: The present invention relates to a manually operable input apparatus (202) for a portable electronic processing device (102), such as a mobile phone or hand-held processor. The apparatus defines a plurality of regions (303, 304) each representing a respective data item and comprises a plurality of sheets configured to produce a response to a mechanical interaction. Furthermore, the sheets are configured to be wrapped around the device to provide a protective cover.

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patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

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4 April 2002

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/01444

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F3/02 G06F1/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, IBM-TDB, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X Y	WO 00 10878 A (TREKWARE CORP :WEISHAAR THOMAS (US)) 2 March 2000 (2000-03-02) the whole document ---	1-6.8, 10.11, 15-19, 21-24 12-14
X	DE 295 12 808 U (KUSCHEL PIETER) 21 March 1996 (1996-03-21) the whole document ---	1-4, 6-10.20, 22-24
X	PATENT ABSTRACTS OF JAPAN vol. 017, no. 316 (M-1430). 16 June 1993 (1993-06-16) & JP 05 031963 A (BROTHER IND LTD). 9 February 1993 (1993-02-09) abstract --- -/--	1.2.4,6. 7.20, 22-24

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search	Date of mailing of the international search report
1 November 2001	08/11/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl Fax. (+31-70) 340-3016	Bailas, A

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International Application No
PCT/GB 01/01444

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication where appropriate, of the relevant passages	Relevant to claim No
Y	EP 0 092 731 A (MATSUSHITA ELECTRIC IND CO LTD) 2 November 1983 (1983-11-02) page 4, paragraph 2 -page 6, paragraph 1 page 10, paragraph 1 -page 11, paragraph 1	12-14
P,X	WO 00 54479 A (RENFER ROBERT O) 14 September 2000 (2000-09-14) abstract page 3, paragraph 3 page 5, paragraph 5	1-4, 7-10, 21-24

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Information on patent family members

Ir[redacted]al Application No
PCT/GB 01/01444

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 0010878 A	02-03-2000	AU 5565799 A	14-03-2000
		WO 0010878 A2	02-03-2000
DE 29512808 U	21-03-1996	DE 29512808 U1	21-03-1996
JP 05031963 A	09-02-1993	NONE	
EP 0092731 A	02-11-1983	JP 1674971 C	26-06-1992
		JP 3038615 B	11-06-1991
		JP 59057360 A	02-04-1984
		DE 3380234 D1	24-08-1989
		EP 0092731 A1	02-11-1983
WO 0054479 A	14-09-2000	AU 2791800 A	28-09-2000
		WO 0054479 A2	14-09-2000

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